

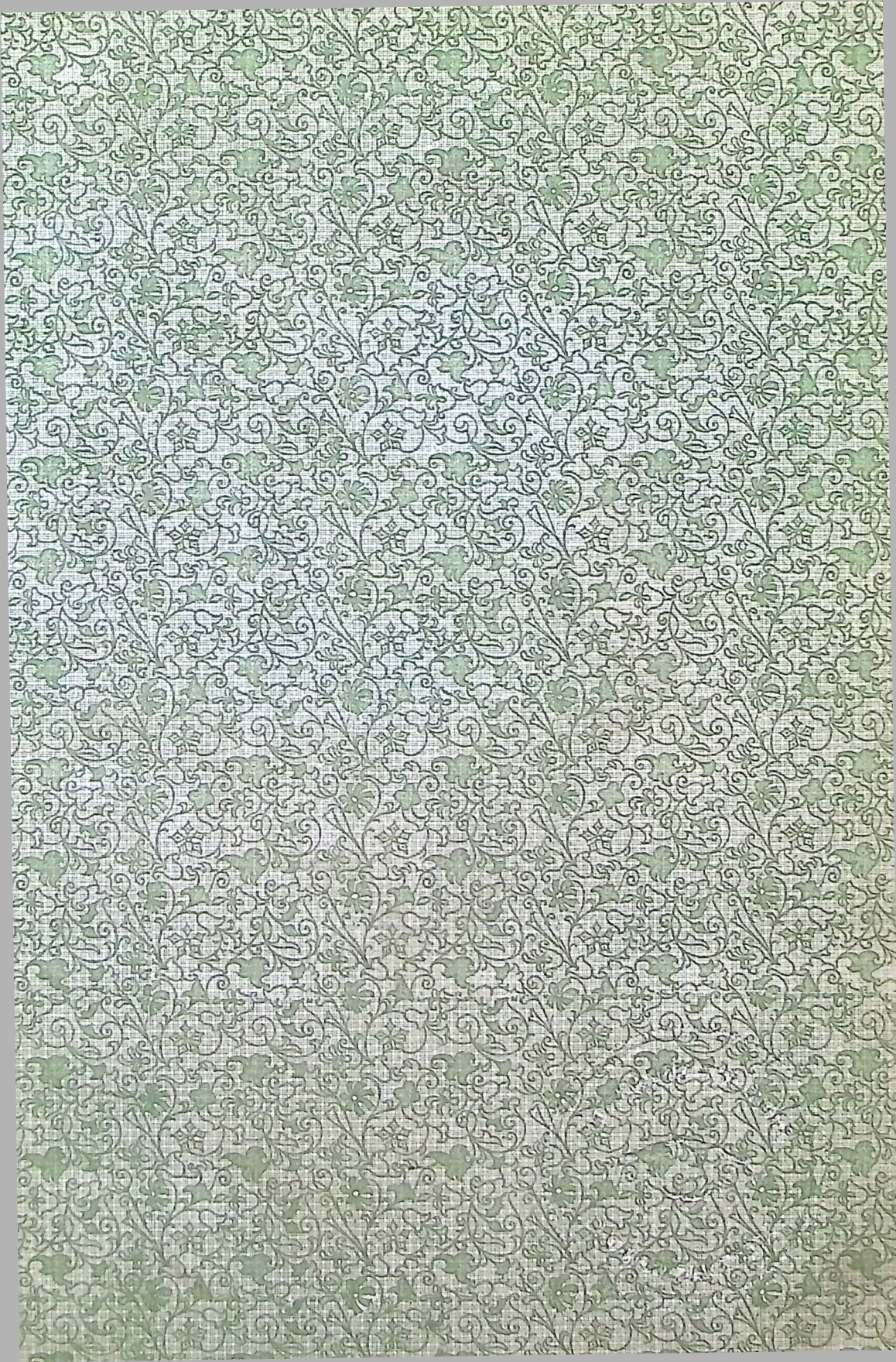
CHIROPRACTIC  
ORTHOPEDY

CRAVEN

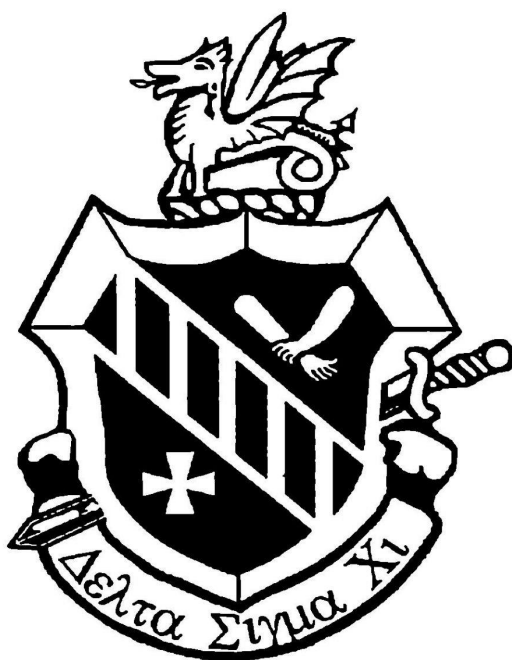
**CHIROPRACTIC  
ORTHOPEDY**

**VOL. XV  
CRAVEN  
1921**





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A TEXT-BOOK  
ON  
**Chiropractic Orthopedy**

BY  
J. H. CRAVEN, D. C., Ph. C.  
*Professor of Orthopedy and Philosophy  
in the Palmer School of Chiropractic  
(Chiropractic Fountain Head)*


FIRST EDITION  
1921

Publisher: J. H. Craven  
Davenport, Iowa



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J. H. CRAVEN, D. C., Ph. C.  
Davenport, Iowa

TO MY FAMILY  
My Wife, My Son, My Daughter  
Whose Love and  
Devotion  
Are My Constant Inspiration  
Is This Book Gratefully  
DEDICATED

A decorative border runs vertically along the left edge of the page, featuring intricate, repeating scrollwork and floral patterns.

"Man is but a reed, the weakest thing in nature, but he is a thinking reed. It is not necessary that the entire universe arm itself to crush him. A breath of air, a drop of water, suffices to kill him. But were the universe to crush him, man would still be more noble than that which kills him, because he knows that he dies, and the universe knows nothing of the advantage it has over him."—Pascal.

"There is no wealth but life: life, including all its powers of love, of joy, and admiration."—Ruskin.



*J.H. Craven, D.C., Ph.C.*



## Preface

The best authority to consult in the preparation of a text-book on the spine is the spine itself. During eight years as instructor of Chiropractic Orthopedy the author has had opportunity to examine many hundreds of specimens of the human spine, normal and abnormal. The spinal column has been considered by anatomists the same as the other osseous structures of the body, but no more importance has been attached to this study than to that of the other parts of the body. Little information can be secured from previous text-books on the subject. Therefore it has been necessary to glean the information from other sources and the chief source of information has been the Osteological studio of the P. S. C. where much research work has been done in the preparation of this volume.

Great care has been exercised in the preparation of the pictures used, that the measurements and all information be exactly correct. Where there has been a difference existing between the different specimens used, the general average has been taken as the standard.

The author has not been ambitious to make a large book but he has been anxious to adapt the work to the practical needs of the student. This book is in no sense exhaustive on the subject of Chiropractic Orthopedy, but it is sufficiently complete to give the student a comprehensive knowledge of the spine so that he will be able to find the physical representation of the cause of disease.

J. H. Craven

Palmer School of Chiropractic,

Davenport, Iowa.

May, Nineteen Hundred and Twenty-One.

## Acknowledgments

The publication of this book has been very materially assisted by my many friends who have been untiring in their help and encouraging words.

The author desires to express his appreciation to his fellow faculty members who have encouraged him greatly in his efforts.

To Dr. M. Belle Larson, Professor of Philosophy, in the Palmer School of Chiropractic, for untiring efforts and most valuable service rendered in the production of this book. Especially has Dr. Larson assisted in the correction of the MSS.

To Dr. R. W. Stephenson, member of the P. S. C. Faculty, for the interest he has shown in making the drawings from which the zinc etchings were made, an explanation of which is given in the article on "The Illustrations."

To my good friend, P. A. Remier, technician in the Spinograph Department of the Palmer School of Chiropractic, who has assisted me in the preparation and production of the silver prints from which many of the drawings were made. He has assisted in this production as only a true friend could.

And what shall I say of my appreciation and deep gratitude to Drs. Mabel H. and B. J. Palmer. Had it not been for these two noble people there would have been no effort made to publish a text-book on Chiropractic Orthopedy. Dr. Palmer has made many valuable suggestions and has encouraged me in many ways, for which I am truly grateful. Dr. Mabel H. Palmer has by her kindly advice and valuable counsel, been a source of inspiration in my efforts. I especially wish to acknowledge my great indebtedness to her for her

criticisms of the drawings and the section on ligaments and muscles. I sincerely hope that this book and what it may accomplish for the profession may not be a disappointment to Dr. and Mrs. Palmer.

Chiropractic Anatomy by Palmer, Cunningham's Anatomy, Gray's Anatomy, Human Anatomy by Piersol, and works on Orthopedic Surgery by Lovett, Farnum, Bradford and Shaffer were used as reference books in the preparation of "Chiropractic Orthopedy."

In the preparation of the section on Ligaments and Muscles the text on Chiropractic Anatomy has been closely followed, with the kind permission of the author, Dr. Mabel H. Palmer.

A word of appreciation of the cooperation from the Photo Arts Co., of Moline in the production of the zinc etchings is not out of place at this time.

I wish also to thank Mr. Franzen, their salesman, for his suggestions and the interest which he has shown in the etchings.

To Printing Products Corporation of Chicago, the printers, I wish to express my appreciation for their kind suggestions and cooperation in the printing of this book.

Last but not least, I wish to thank the many students and graduates of the P. S. C. for their encouraging words. Had it not been for the insistent demand from the students for a text book on Chiropractic Orthopedy no effort would have been made to publish such a book.

## Osteological Studio

### Palmer School of Chiropractic

Few students appreciate the value of a complete Osteological Studio and realize the benefit to be derived by having access to a Studio in which he has the opportunity of studying by means of his own observation and introspection, not only the normal but also many abnormal and pathological specimens. There is no finer Osteological Studio to be found anywhere, either in this country or abroad, than that maintained by the Palmer School of Chiropractic for the advantage of its students.

This is the largest and most complete studio of its kind in the world. Dr. Palmer has spent thousands of dollars in assembling this fine collection so extensive in its range and variety. It has taken twenty-five years to collect these specimens which have an approximate value of \$30,000.

The studio consists of over 4,000 specimens of every conceivable normal and abnormal condition to which the human skeleton is heir. Of human spines alone there are 132, and yet when one of the leading schools of this country had 84 spines in its collection it was considered the finest in the world. Here, however, is a studio, to which the 2,500 students attending have daily access, in which there are almost double the number of spines. In addition, there are 24 complete skeletons, among which is a rachitic skeleton in which every bone is said to be abnormal. On one shelf of this wonderful studio are 110 atlases, no two of which are alike. There are also 10,000 specimens of individual segments of the human skeleton besides various bones of lower animals. These are of great interest as a means of comparison. One

curiosity is the spine of a huge boa constrictor which consists of 400 separate segments.

One feature of interest in this studio is the foetal specimens. There are on display 8 baby skeletons of various sizes, 34 baby skulls ranging in size from a pigeon egg to a normal head at the age of one year and several wet specimens showing various stages of foetal development.

It is possible to show drawings of only a small number of these specimens in a book of this kind but the student has ready access to this studio for it is open at all times, not only to the students but to the public as well.

I wish to refer to the Osteological Studio of the Palmer School of Chiropractic as my authority in the preparation of this work on Chiropractic Orthopedy and I do not believe that better authority can be found than the specimen itself.

## The Illustrations

It is the opinion of the author that an explanation of the illustrations, the preparation of the drawings and the specimens from which they were taken would be of interest to the student.

The illustrations are all zinc etchings; there are no half tones used. In order to make a zinc etching it is necessary to have a pen line drawing for an etching can not be made from a photograph. Dr. R. W. Stephenson made all the line drawings, many of which are free hand sketches. The others are inked over silver print photograph. The photo was then faded out leaving only the line drawing which is absolutely exact in every detail and identically the same as the photograph. By this method it is possible to make a zinc etching, which is much more desirable for study than the half tone.

Most of the drawings are life size. They were made from specimens taken from the P. S. C. Osteological Studio, except, of course, the drawings of the ligaments and the muscles. Wherever ligaments and muscles are shown on segments of the spine or parts of the skeleton, those segments or skeleton parts were made from actual specimens.

The drawings of all the segments that are used in the comparative study of the vertebrae of the spine are line drawings which were made from photographs. The line drawings were made over the photograph, then placed in a chemical bath and the photograph faded out leaving only the line drawing. These drawings are all true to the specimen from which they were made.

The illustrations have all been made the exact size of

the specimen as far as possible, and where they are not the same size great care has been exercised to make them in the proper proportions. The drawings are all original; no cuts have been used from other text-books. The two cuts of the pelvis showing the anterior and posterior ligaments are very much the same as two in Chiropractic Anatomy by Dr. Mabel H. Palmer. The pelvis, however, was drawn from a specimen from the studio and the ligaments placed upon it are the same as those shown by Dr. Mabel H. Palmer.

The photographs were taken by the author assisted by Mr. P. A. Remier, who did all the developing, enlarging and the reducing or fading of the photographs after the line drawings had been made.

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## **PART I**

**Introduction**

**Spinal Column**

**Spinal Canal**

**Spinal Cord**

**Spinal Cord Pressure**

**Typical Vertebra**

## Introduction

### Chiropractic Orthopedy

It is generally conceded that a Frenchman by the name of Andry was the founder of Orthopedic Surgery. The word ORTHOPEDIC is a combination of two Greek words—orthos meaning straight, and pais meaning child. Therefore the word orthopedic means "to make a child straight."

Originally the word orthopedia was applied only to the correction of the deformities of children and more especially to the deformities of the spine. In more recent years it has been applied to that branch of surgery which is used for the prevention and correction of deformities not only of children but also of adults as well.

CHIROPRACTIC, like orthopedy, is derived from two Greek words cheir, the hand and praktos, meaning done. Chiropractic Orthopedy, therefore, according to the etymology of the words, means the prevention and correction of deformities by adjusting the cause with the hands.

Orthopedic Surgery uses many appliances and mechanical devices together with operative surgery for the purpose of correcting the deformities and abnormalities of the body. In defining orthopedic surgery Dr. Shaffer says: "Orthopedic surgery is that department of general surgery which includes the mechanical and operative treatment of chronic and progressive deformities, for the proper treatment of which specially devised apparatus is necessary."

Operative procedures have always been considered as occupying a secondary place in orthopedic procedure. The greater emphasis, by far, being placed upon the mechanical

treatment of deformities. In short, says Dr. Shaffer, "If orthopedic surgery is to maintain its position among the specialties of medicine, it must exist upon a mechanical foundation and its disciples must be experts in the use of apparatus."

"Whether, therefore, the condition be one of lateral curvature or spinal caries, the indications are to be studied and these indications are to be met from a pathological, anatomical, surgical, and mechanical standpoint. To do this the orthopedic surgeon must be fully informed upon general medicine and surgery and must be prepared to prescribe his apparatus as precisely as a general practitioner prescribes a remedy for disease."

Dr. Farnum in his text book on Lateral Curvatures of the Spine says: "In mild cases and those of short duration, the curves straighten out under suspension. A mechanical support is demanded in some cases, not to forcibly correct the deformity, but to act as a support where the spinal structures, ligaments and muscles are too weak to carry the load."

Dr. Whitman, an eminent authority on Orthopedic Surgery says: "It may be stated of forcible correction of the spine, that it is in no sense curative; that although it has been proven that the back can be straightened in many instances with ease, and in most cases with but little danger, yet the retention of the spine in the corrected position is difficult, and a certain immediate recoil towards deformity is the rule."

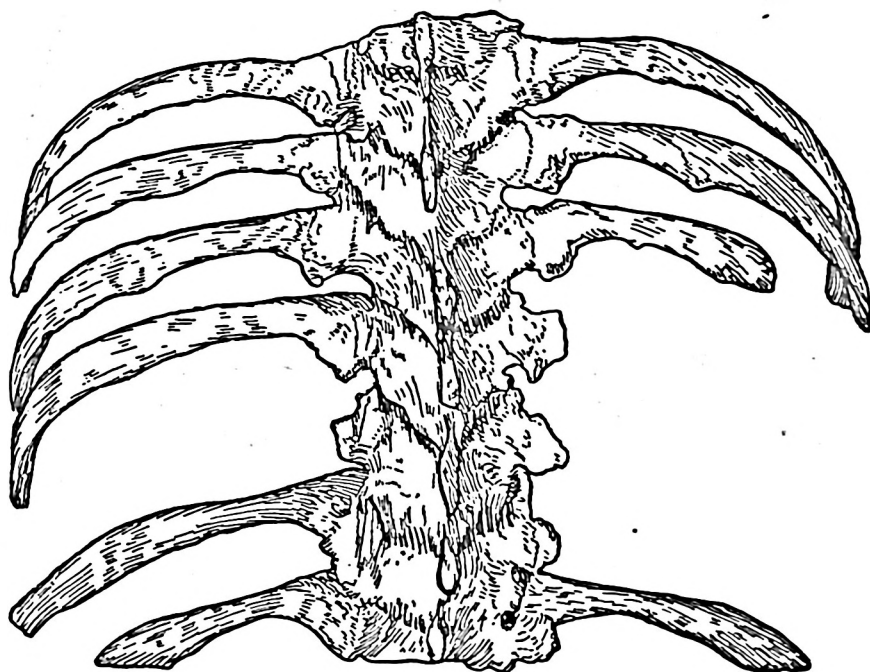
Bradford and Lovett have the following to say in regard to the treatment of caries of the spine: "In suspension, in old caries of the spine, it is only the physiological curves which are obliterated, the sharp kyphosis is held too firmly by inflammatory adhesions to admit of correction; in earlier cases with movable vertebrae, intervertebral pressure may be, in a

measure, diminished at the point of disease by suspension, but suspension does not cause a disappearance of the sharp angular projections at the point of disease, and in cases that present themselves for treatment the deformity can not be corrected in that way. In patients suffering with the symptoms of Potts' disease, relief may be afforded by suspension.

"It is now recognized that the deformity itself cannot be changed, the vertebral column above and below the gibbosity may be extended and straightened, but the diseased area remains fixed. In fact, attempts to accomplish this have been followed by immediate paraplegia and even death."

In Chiropractic no such methods are used. If there is a deformity there must be a cause for that deformity, which must be found and removed. Chiropractic Orthopedy is the science of the correction of the cause of abnormalities and deformities of the body by adjusting the cause by hand. In the administration of Chiropractic orthopedy there are no mechanical devices or appliances and no surgical methods used. The desired end is accomplished by means of Chiropractic adjustments only.

In cases of congenital deformities the cause may be found in the spine of the mother. Therefore, to prevent the development of abnormalities in the foetus, the subluxations of the mother must be adjusted, that the reproductive organs may perform their normal function.



*Part of Dorsal Region—showing  
Ankylosed vertebrae & Ribs.*

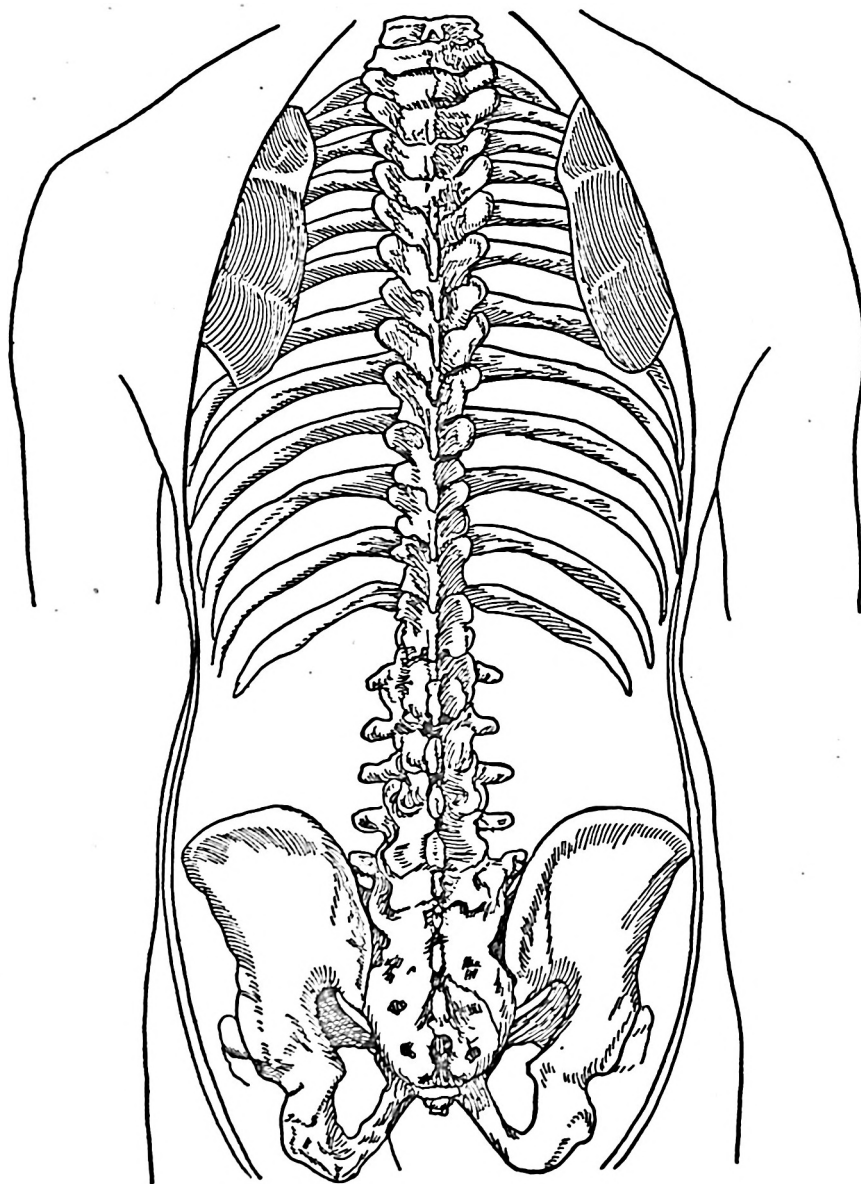


Fig. 1.

### Location of the Spinal Column

Figure No. 1 is a unique picture showing the spinal column in the posterior median line of the body. It shows a posterior view of the spinal column and its connection with the ribs and the ilii.

The student will find a careful study of this cut of special value as a means of comparison, since it shows the relation of the spinal column to the surrounding parts. This illustration will give a very clear mental picture of just how all the weight of the body is anterior to the central shaft which supports this weight. It can thus be seen why it is necessary to have curves in the spine for the purpose of equalizing this weight.

This cut is not used for the purpose of showing the spine in detail, but is merely for the purpose of giving a general idea. The student is referred to Fig. 4 for a more thorough study of the posterior view of the spinal column.

## The Spinal Column

The Spinal Column is a flexible, flexus column located in the posterior medial line of the body. See Fig. 1. In the adult it is composed of twenty-six irregular shaped segments of bone called Vertebrae. The first twenty-four of these segments are known as the true vertebrae and comprise the movable part of the column. The last two are called the false vertebrae and have been given the name of Sacrum and Coccyx.

In early life the spinal column consists of thirty-three segments of bone divided as follows:

Cervical Vertebrae	Dorsal or Thoracic Vertebrae	
Seven	Twelve	
Lumbar Vertebrae	Sacrum	Coccyx
Five	Five	Four

The first twenty-four vertebrae are separated from each other by discs of white fibro-cartilage located between the bodies. As these discs do not ossify, the segments remain movable, therefore they are called the true vertebrae, being true to the name "vertebra" which is taken from the word "vertere," meaning to "turn." This region is known as the SPINE.

During childhood the segments of the Sacrum are separated by cartilage, but this cartilage being hyaline in nature is prone to ossify, causing these segments to coalesce about the age of puberty, thus forming the Sacrum into one solid bone. The segments of the Coccyx are also separated from

each other by hyaline cartilage in early life, which likewise ossify, producing the coalescing of these segments about the same time as those of the Sacrum and thus forming the Coccyx into one bone instead of four. Instead of the Sacrum and Coccyx consisting of nine segments in adult life they consist of only two. These are called the false vertebrae because their segments do not remain movable. Because of this change taking place in the Sacrum and Coccyx the adult spinal column consists of twenty-six segments instead of thirty-three as in childhood.

Considerable confusion is experienced in differentiating between the Spine and the Spinal Column. As a matter of fact, anatomists pay little attention to this distinction, but in our work we find it convenient to make a distinction. The Spine consists of the twenty-four movable vertebrae. The Spinal Column consists of the Spine together with the Sacrum and the Coccyx. The Spinal Column of the adult has twenty-six segments while that of the child has thirty-three.

### The Length of the Spinal Column

The length of the Spinal Column is from twenty-seven and one-half inches to twenty-eight and three-quarters inches, while that of the Spine is about twenty-three inches. The length of the different regions is about as follows:

Cervical region	Dorsal region	Lumbar region
Five inches	Eleven inches	Seven inches
Sacrum and Coccyx		
Five and three-fourths inches		

The best way of designating the length of the Spine is by comparison with the height of the individual, the spine being about one-third of the height. In this comparison, how-

ever, the student must not confuse the spinal column with the spine, for if he does, the mental picture will be that of an individual very much out of proper proportion. There is not as much variation in the length of the spine in different people as might be imagined, for the difference in height depends largely upon the length of the lower extremities rather than upon the difference in the length of the spine. The Spinal Column of the female is but very little shorter than that of the male, there being about three inches difference.

## The Shape of the Spinal Column

### Anterior View

Fig. 2.

#### Pyramids.

A ventral view of the spinal column reveals the bodies of the vertebrae and the transverse processes may be seen at either side projecting past the bodies. It will be observed that the bodies of the vertebrae vary in their transverse width and that this variation is so arranged as to form pyramids, hence we say the spinal column is pyramidal in shape. Two general pyramids are plainly visible. One, from the axis to the fifth lumbar, formed by the twenty-four true vertebrae; the other, a short inverted pyramid, formed by the Sacrum and the Coccyx. Upon close examination it will be found that the long pyramid formed by the spine and extending from the axis to the fifth lumbar inclusive is divided into three subdivisions, each subdivision forming a pyramid.

It is essential that the student form a good mental picture of these pyramids, since they are formed by the transverse width of the bodies of the vertebrae, which variation in a large measure determines the size and shape of the vertebral canal.

The transverse width of the bodies increases from above downward to the body of the first dorsal, thus forming the first pyramidal subdivision, from the Odontoid process on the body of the Axis, which forms the apex, to the body of the first dorsal vertebra which forms the base. The second sub-

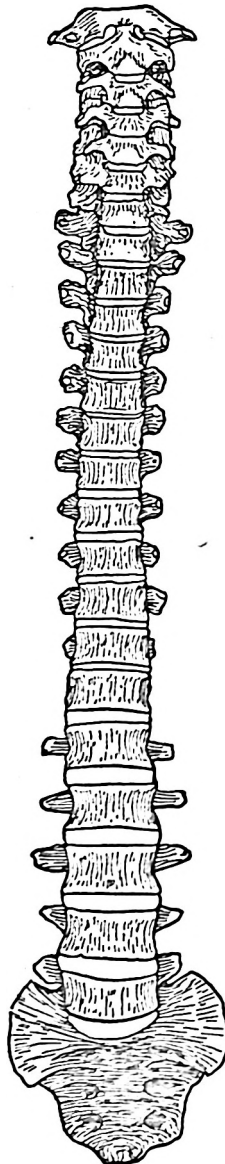


Fig. 2. Anterior View of the Spinal Column.

division extends from the body of the first dorsal down to the body of the fifth dorsal vertebra, and as the transverse width of the bodies decreases from above downward between these two points the pyramid is an inverted one; the body of the first dorsal forming the base, while the apex is formed by the body of the fifth dorsal. As the bodies increase in size from the fifth dorsal to the fifth lumbar the third subdivision of this long pyramid extends between these two vertebrae. The body of the fifth dorsal forms the apex, the base being formed by the fifth lumbar vertebra.

The second or inferior pyramid of the spinal column is formed by the Sacrum and Coccyx and is inverted, that is, the base is upward and the apex downward. The base articulates with the fifth lumbar vertebra while the apex is formed by the tip of the coccyx.

From this anterior view of the spinal column will be observed, also, two convexities and two concavities which are produced by the anterior and posterior curves. The convexities are found in the cervical and lumbar regions and are formed by the anterior curves in these regions. The concavities are found in the dorsal and pelvic regions and are formed by the posterior curves. In looking at the spinal column from the posterior these convexities and concavities would be just reversed. The cervical and lumbar regions would present the concavities while the dorsal and pelvic regions would present the convexities.

### Lateral View

#### Fig. 3.

#### Curves.

Viewed laterally the spinal column is shaped something like the letter "S" somewhat straightened out. There are

four curves, two posterior and two anterior. These curves are called the Primary and Secondary curves. The Primary curves are the Posterior curves and appear very early in foetal life. At first instead of two curves there is only one continuous posterior curve the entire length of the spinal column, which is formed by the shape of the bodies of the vertebrae.

About the time the child begins to assume the erect position and sit alone this gradual curve of the spine toward the posterior is divided by an anterior curve in the lumbar region. This anterior curve in the lumbar region helps to equalize the weight of the body and enables the child to assume the erect posture with the center of gravity falling between the feet, and at the same time enjoy a degree of relaxation which could not obtain if this erect posture had to be maintained through the expression of motor function in the muscles of the back. This curve brings about proper compensation, since the larger portion of the weight of the body is anterior to the central weight-bearing shaft of the body.

At first this anterior curve is maintained by the expression of motor mental impulses in the muscles of the back, but as Innate Intelligence recognizes the necessity for the permanent equalization of this weight, a change in the shape of the intervertebral discs is brought about and they become permanently wedge-shaped in this region, thinner at the posterior than at the anterior. This anterior curve is maintained permanently by the wedge-shaped intervertebral discs. There is also an anterior curve in the cervical region which permits the head to be held erect. The same changes take place in the intervertebral discs here as take place in the lumbar region.

The degree to which these curves are bent, especially the anterior curves, is influenced very largely by the build of the

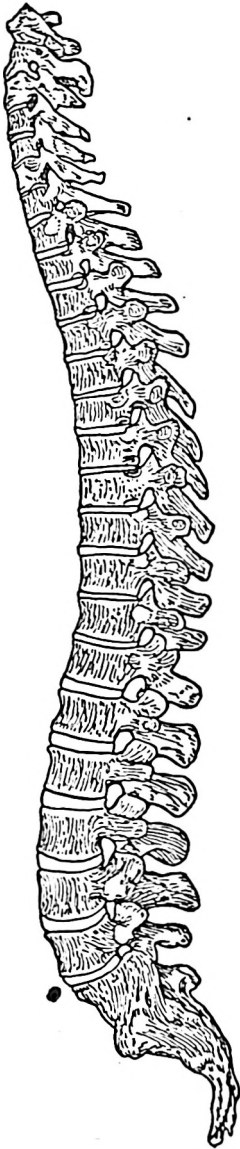


Fig. 3. Lateral View of the Spinal Column.



Fig. 4. Posterior View of the Spinal Column.

trunk and the carriage of the body. If there is increased weight at the anterior, we find the compensative curve in the lumbar region exaggerated. Increased obesity, abdominal tumor, pregnancy, or other conditions may obtain which, by increasing the weight at the anterior would make necessary an adaptative increase in the lumbar curve. The increase in the anterior curve in this region would not constitute an abnormality but would merely be compensative to the other existing condition and would perform the specific function of equalizing the increased weight at the anterior. In the case of pregnancy there would be a readaptation take place after parturition which would result in the lumbar region returning to its original curve. If, however, this readaptation does not take place and this curve remains exaggerated after the weight at the anterior has disappeared, then the exaggeration becomes an abnormal condition; it can no longer be considered as a curve but becomes a curvature, the cause of which must be found and adjusted. The curves of the spine perform other functions than that of equalizing the weight of the body. They absorb much of the jar and jolting which would otherwise be transmitted to the head and damage the cranial contents. They also give shape and beauty to the body, there being, "no beauty in straight lines."

### Posterior View

Fig. 4.

In viewing the spinal column from the posterior there will be observed a concavity in the cervical and the lumbar regions, and a convexity in the dorsal and pelvic regions. In the median line extending from the Axis to the base of the Sacrum there is a longitudinal tubercular ridge formed by the spinous processes of the vertebrae. Laterally, and on either

side of the neural arches are the transverse processes. Between the spinous processes and the transverse processes on one side, and the spinous processes and the transverse processes on the other side, are two grooves or depressions the entire length of the spine. The floor of these grooves is formed by the posterior surface of the laminae and the inferior articular processes. These grooves are known as the vertebral grooves and in them are found the large muscles of the back which assist in holding the body erect and also produce and control the movements of the spine.

### Functions of the Spinal Column

In order that the student may more fully appreciate the importance of the spinal column it is quite necessary that he very carefully consider the functions which it performs. These functions are not named in the order of their importance, and the only reason we have numbered them is merely to assist in remembering them. There are numerous minor functions which might be mentioned, but these given are the most important:

- A. The spinal column supports the head.
- B. We find in the spinal column a means of decreasing the amount of shock and jar that would otherwise reach the head and do more or less damage to the contents of the cranium.
- C. It holds the body erect.
- D. The weight of the body is supported by the spine which also transmits the weight to the pelvis.
- E. The spine being flexible allows for all the movements of the body, such as extension, counter-extension, flexion and rotation.

- F. In the dorsal region the segments of the spine help to form the thorax and also give attachment to the ribs.
- G. The spinal cord passes out through the Foramen Magnum and is protected on its downward course by the spinal column.
- H. It allows also for the transmission of the spinal nerves through the intervertebral foramina as they are given off from the spinal cord.
- I. The spinal column performs the same function as do the other bones of the body in that it helps to form the skeleton and serves to give attachment to the ligaments and muscles.
- J. The spinal column gives shape and grace to the body.
- K. All parts of the body are directly or indirectly attached to the spinal column.

The bodies of the vertebrae, also called the centra, are so placed, one on top of the other with the intervertebral discs between, as to form a more or less solid column anteriorly, which provides the chief axis of support for the head and trunk, while the neural arches form a canal posteriorly for the transmission of the spinal cord and its coverings.

## Vertebral Canal or Spinal Canal

It is important in the consideration of the spinal column to consider very carefully the spinal canal through which the spinal cord passes. This canal extends through the center of the spinal column from the Foramen Magnum to the apex of the sacrum. It is formed by all the neural rings together when the vertebrae are in articulation with each other. The neural ring is formed by the body of the vertebra together with the neural arch which is formed by the pedicles and laminae.

This canal varies in shape and size in the different regions of the spine. Recalling to mind the pyramids formed by the lateral diameter of the bodies in the subdivisions of the pyramidal shaped spine, an idea will be obtained of the differences in the size and shape of the canal in the several regions. The canal is largest in the cervical and lumbar regions corresponding to the cervical and lumbar enlargements of the spinal cord. From the third cervical vertebra downward to the first dorsal vertebra the transverse diameter of the bodies increases and likewise the size of the vertebral canal, but from the first dorsal vertebra downward to the fifth dorsal vertebra the transverse diameter decreases, thus diminishing the size of the vertebral canal between these two points. From the fifth dorsal vertebra to the fifth lumbar vertebra the transverse diameter is increased, thus producing a gradual enlargement in the size of the canal as the lumbar region is approached. The spinal or vertebral canal is triangular in shape in the cervical and lumbar regions, but in the dorsal region it is more circular.

The movements of the spine are greatly reduced in the dorsal or thoracic region by the attachment of the ribs and for this reason the canal may, without danger of pressure on the cord, be smaller at this part of the spine than in the cervical and lumbar regions where there is a greater demand for a larger variety of movements, as in the turning of the head which requires great flexibility of the neck and the movements of the trunk which take place largely in the lumbar region. The cord is protected in the canal by three spaces, the subarachnoid, subdural and the epidural. These spaces contain the spinal fluid and act as a protection to the cord in its course through the vertebral canal.

#### Neural Arch.

The neural arch of a vertebra is formed by the pedicles which project backward from either side of the posterior aspect of the body of the vertebra, and the laminae which project backward from the pedicles and converge to complete the arch at the posterior. The neural ring of a vertebra is formed by the neural arch together with the posterior surface of the body. When the vertebrae are in proper articulation with each other all the neural rings together form the neural canal, also called the vertebral canal.

The vertebral canal, or spinal canal as it is sometimes called, is for the transmission and protection of the spinal cord and its coverings. The spinal nerves have their exit from this canal through apertures between the segments of the spine. These openings are called intervertebral foramina. In the different regions of the spine this canal differs in size. The greater mobility there is to the spine, the larger must be the vertebral canal for the purpose of protecting the spinal cord from pressure produced by this movement.

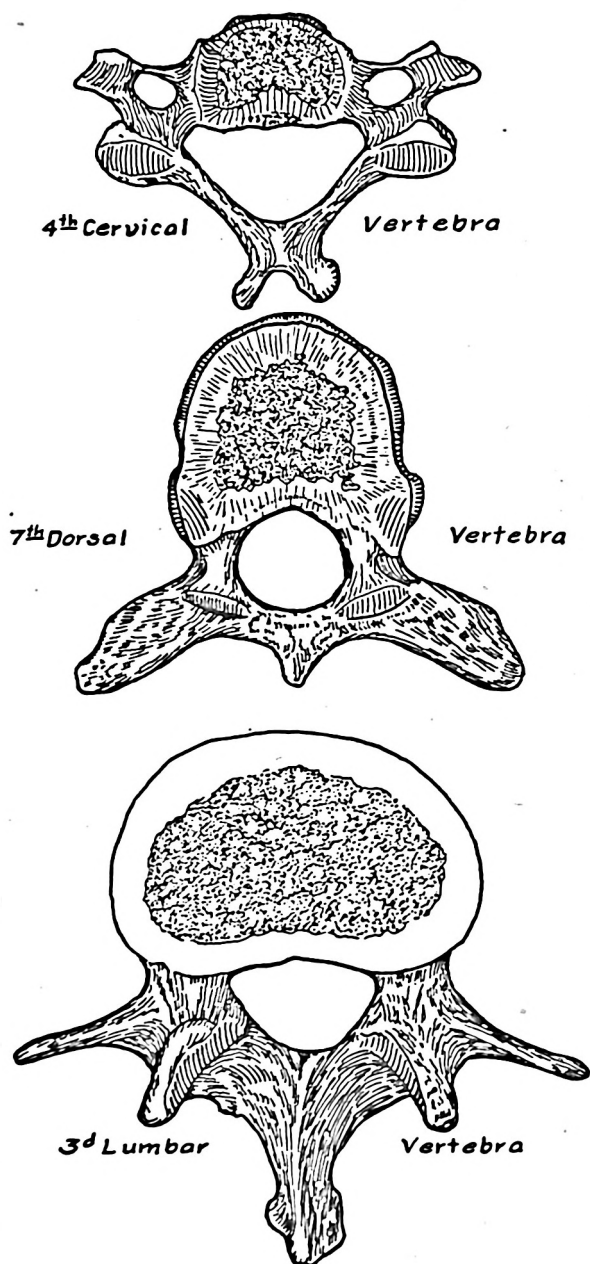
**Cervical Region—Fig. 5.**

In the cervical region there is great mobility and we find that the vertebral canal is larger here than in the dorsal region. The vertebral canal in the cervical region is somewhat triangular in shape. The transverse width of the bodies of the cervical vertebrae is greater than the length of the vertebral arches, making the transverse diameter of the vertebral canal greater than the antero-posterior. Another reason for the canal being larger in this region is because of the cervical enlargement of the spinal cord.

**Dorsal Region—Fig. 6.**

In the dorsal region the vertebral canal is circular in shape and smaller than in the cervical region. In this region the pedicles are not set so far apart at the point where they are attached to the bodies, therefore the transverse diameter of the ring is about equal to the antero-posterior diameter. There is less mobility in this region of the spine. The segments are held very firmly by the ribs, therefore there is not much danger of injury to the spinal cord by the movements of this part of the body and there is little danger of spinal cord pressure.

From the first dorsal to about the fifth dorsal the spinal canal gets smaller. At the fifth, the sixth, the seventh and possibly the eighth dorsal it is about the same in size, but from here on down to the twelfth it gets gradually larger, for there is greater mobility in the spine as the region of the loins is approached, and again we have the necessity for greater protection to the spinal cord. The mobility of the eleventh and twelfth dorsal vertebrae is greater than that of the other dorsal vertebrae. This is made possible by the last two pairs of ribs not being attached to the sternum at the



Figs. 5, 6, 7. Shape of the Vertebral Canal in the Different Regions of the Spine.

anterior. We also find an enlargement of the cord at this point.

**Lumbar Region—Fig. 7.**

In the lumbar region the vertebral canal is found to be somewhat flattened. The transverse width of the body is, in this region as in the cervical region, greater than the length of the vertebral arches, which makes the transverse diameter of the vertebral ring greater than the antero-posterior. Since the spinal canal is formed by the neural rings of the vertebrae we find that the spinal canal in the lumbar region is larger than in the other regions of the spine and that it is wider from side to side than from before backward. In this region of the spine the spinal cord has spread out and forms what is known as the Cauda Equina and is therefore much larger than in the other regions of the spine, necessitating greater size in the spinal canal here.

## The Spinal Cord

Fig. 8.

The spinal cord is a soft white cylinder of nerve fibers which is contained inside of the spinal canal. It extends from the foramen magnum in the occipital bone to the first lumbar vertebra, where it ceases to exist as a cord. Here the fibers spread out somewhat in the shape of a horse's tail and is called the Cauda Equina. These diverging fibers are formed by a collection of nerve roots which arise in the lumbar enlargement and proceed downward through the canal. Anteriorly, it is slightly flattened to correspond to the shape of the spinal canal.

Being of smaller dimensions than the canal through which it passes and the space between the cord and the walls of the canal being filled with soft tissue, the spinal cord is not subject to pressure or likely to be injured during the ordinary movements of the spine. This is clearly an intellectual adaptation whereby there may be much movement of the spine without interfering with the carrying capacity of the nerves of the spinal cord. Since the function of the spinal cord is to transmit mental impulses from the brain to the organs of the body and vibrations back to the brain from the tissue cells, it is necessary that nothing interfere with the carrying capacity of the spinal nerves.

The spinal cord is protected in its downward course by a sheath composed of three covering membranes and three

spaces. The coverings of the cord are: (a) Pia Mater, (b) Arachnoid, (c) Dura Mater.

The Pia Mater is the innermost layer of the coverings of the cord. It is a very delicate membrane consisting of an outer and an inner layer. The inner layer is composed of a network of small blood-vessels, while the outer layer consists of connective tissue with longitudinal fibers. The Pia Mater is very closely attached to the surface of the cord extending into the fissures and supplying the nerve tissue with blood. The larger blood-vessels are contained between the two layers. The Pia Mater of the spinal cord is continuous with that of the brain, but it is much heavier because the outer layer is more highly developed.

The Arachnoid membrane is the middle layer of the coverings of the cord. It is a very delicate, transparent, weblike membrane. It begins at the foramen magnum and extends the full length of the cord enveloping the Cauda Equina. This membrane forms a sheath for the spinal nerves as they arise from the cord. It ends abruptly after following the nerve for a short distance after its exit from the intervertebral foramen.

The Dura Mater is the outer layer of the coverings of the spinal cord. It is a very loose, strong fibrous tube surrounding the cord. It is attached very securely around the margin of the foramen magnum, the posterior surface of the body of the axis, and the body of the third cervical vertebra. In its course downward in the spine it is separated from the walls of the canal by the epidural space. At the lower end it becomes continuous with the filum terminale which is attached to the apex of the coccyx at the posterior. The Dura Mater forms a sheath for the spinal nerves as they are given off from the

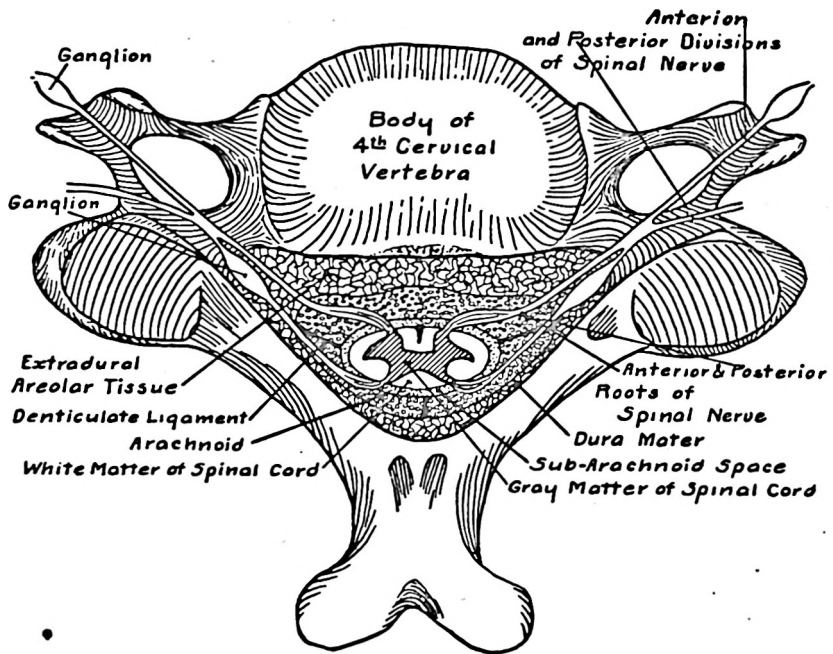


Fig. 8. Spinal Cord.

spinal cord and passes through the intervertebral foramen with the nerve and there ends.

The spaces in the spinal cord are: (a) Subarachnoid, (b) Subdural, (c) Epidural. The Subarachnoid Space, the widest space in the canal, is found between the Pia Mater and the Arachnoid membrane. It contains the cerebral spinal fluid. The Ligamenta Denticulata divides this space into two incomplete divisions, the anterior and the posterior. It is divided into a right and a left compartment which is more or less complete by the septum called the Septum Posticum. The Subarachnoid space communicates with the fourth ventricle of the brain.

The Subdural Space is not much more than a capillary space between the Arachnoid membrane and the Dura Mater. It contains a very small amount of fluid which acts as a lubricant between the two opposing surface membranes.

The Epidural Space is the space which separates the Dura Mater from the walls of the spinal canal. It is filled with soft areolar tissue and a plexus of thin walled blood-vessels.

The spinal cord presents two enlargements, one in the cervical region, the other in the lumbar region. The cervical enlargement begins about the superior border of the body of the fourth cervical vertebra and extends downward to about the second dorsal vertebra. Its greatest breadth is opposite the inferior border of the body of the fifth cervical vertebra. From the cervical enlargement nerves are given off that supply the upper extremities. The second enlargement and the smaller of the two begins at a point just opposite the tenth dorsal vertebra and ends on a level with the second lumbar vertebra. This enlargement corresponds to the large nerve trunks where the large nerves which supply the lower ex-

limbs issue. In the dorsal region the cord is smallest and more nearly circular on cross section.

In Fig. 8 is shown a cross section of the spinal cord inside the neural canal at the fourth cervical vertebra, showing the relationship between the cord and the canal. It also shows how the spinal nerves are given off from the cord and pass through the intervertebral foramina. They arise by two roots, the anterior and the posterior roots, which pierce the Dura Mater, carrying a sheath of it as they pass from the cord. Just outside of the intervertebral foramen they divide into the anterior and the posterior primary divisions.

## Cord Pressure

When we speak of pressure upon a nerve fiber ordinarily we think of the pressure existing at the point where the nerve emits from the spinal column. However, this pressure may exist inside the neural canal. When the pressure exists inside the canal it is spoken of as Cord Pressure. Cord pressure does not, however, necessarily mean that the entire spinal cord is impinged. In the large majority of cases of cord pressure there are only a few fibers that are involved. Usually this pressure takes place at one of the enlargements of the cord.

There are three ways in which cord pressure may be produced:

- (a) Traumatic.
- (b) Pathological conditions in the cord.
- (c) A pulling upon the cord from a subluxation of the sacrum or coccyx.

(a) A subluxation may be produced which will, because of its exaggeration, produce pressure upon the cord as shown in Fig. 10. The number of fibers involved would depend upon the degree to which the vertebra was subluxated. Clinical observation has revealed the fact that in the majority of cases the location of cord pressure is in the middle cervical place. (M. C. P.)

In severe traumatic conditions where there has been a dislocation of a vertebra or where some of the descriptive parts have been fractured, the bony parts may be brought into direct contact with the soft nervous tissue and thus great

pressure be produced. In case of fracture it may be necessary to resort to surgery to remove the particles of fractured bone and thus relieve the pressure. Where there has been great injury done to the cord there may be an proliferation of connective tissue and in this way the function of this part of the cord be destroyed. Complete involvement of the spinal cord is rare. If the cord is severed in the cervical region there will be instant death, while if it is severed in the lower part of the spine there will be death to the body below that point. If the cord pressure exists in the cervical region the symptoms are more exaggerated than when it is farther down in the spine.

(b) Pathological conditions may develop inside the neural canal, producing excessive heat in the meninges or the cord resulting in swelling, development of tumorous growths or the proliferation of connective tissue, which would press against the cord and interfere with transmission. In this event it would be necessary to find the subluxation that was interfering with the transmission of mental impulses to the meninges of the cord and when this pressure was removed, restoring transmission to the meninges, the pathological condition would be restored to a normal condition and the pressure upon the cord would be removed.

(c) A subluxation of the sacrum or coccyx might result in a pull upon the spinal cord in such a way as to produce cord pressure. This is rather unusual, yet there are a number of cases on record which reveal this condition. The sacral nerves do not pass out from the cord through movable foramina as in the other regions of the spine. Therefore, a subluxation of the sacrum does not produce a change in the size or shape of the intervertebral foramina, but it may produce a pull upon the cord and the pressure may be brought to bear

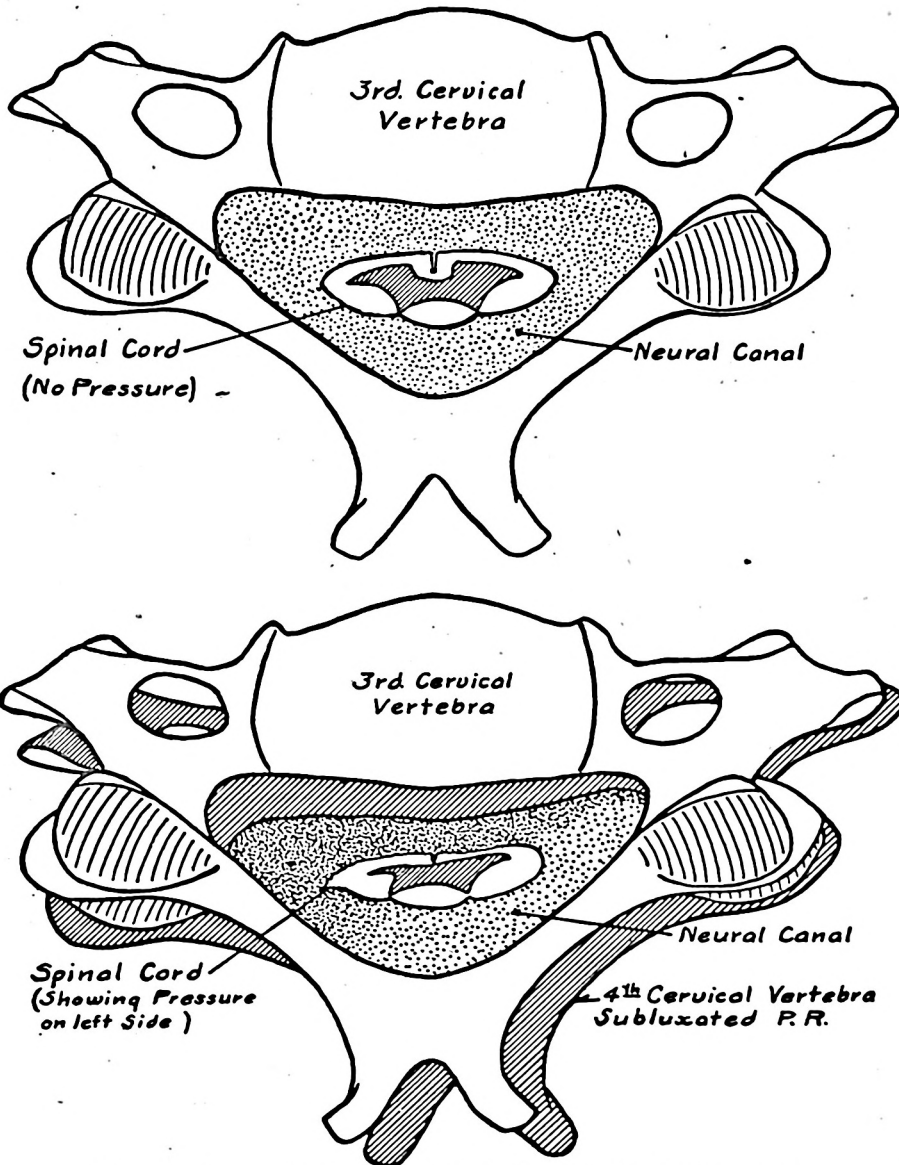


Fig. 9. Cross Section of Spinal Cord Without Pressure.  
 Fig. 10. Cross Section of Spinal Cord Showing Pressure.

upon the cord in any region of the spine. The same condition might occur with a subluxation of the coccyx. As the fibers of the lower part of the spinal cord, including the slender glistening thread called the filum terminale, approach the coccyx they become somewhat fibrous in nature for attachment to the coccyx. A subluxation of the coccyx toward the anterior may cause a sufficient pulling of these fibers to produce cord pressure any place along the entire course of the spinal cord. Tenderness in case of cord pressure may be found all along the spine below the point of pressure.



## Typical Vertebra

### Descriptive parts of a Typical Vertebra.

A Typical Vertebra is composed of a body or centrum and a neural arch which supports seven processes. The neural arch is formed by the two pedicles and the two laminae. The laminae meet in the posterior median line and complete the arch. The seven processes are the two transverse processes, the four articular processes, also called the prezygapophyses and the post zygapophyses, and the spinous process. These parts are called the descriptive parts of a vertebra and they are common to all the true vertebrae in the spine with the exception of the atlas.

While all the vertebrae in the spine, except the atlas, have these descriptive parts, yet they are not all described in the same way, for they differ in their description according to the part of the spine in which they are located. It is, however, advisable for the student to familiarize himself with the names of the descriptive parts and when a description of a vertebra is to be given it should begin with the body of the vertebra and the parts to be described in regular order. The description of the body should be followed with a description of the parts in the following order: Pedicles, the laminae, the transverse processes, the four articular processes and last, the spinous process.

Descriptive parts of a typical vertebra:

One Body or Centrum	Two Transverse Processes
Two Pedicles	Four Articular Processes
One Spinous Process	

If this outline is followed the student will build his mental picture point by point and the picture will be a symmetrical picture rather than a garbled mass of descriptive terms. As a matter of fact, the student will find it a great advantage in the description of a vertebra if he can form a vivid mental picture and then merely describe that mental picture, point by point. The best way to get this mental picture is, not only to study the word descriptions, but to study the cuts in the book and also the segments of the spine. A student should by all means provide himself with a specimen of the spinal column and study that in connection with the text book.

**PART II.**

**Cervical Region**

**Ossification of the Vertebra**

**Intervertebral Foramina**

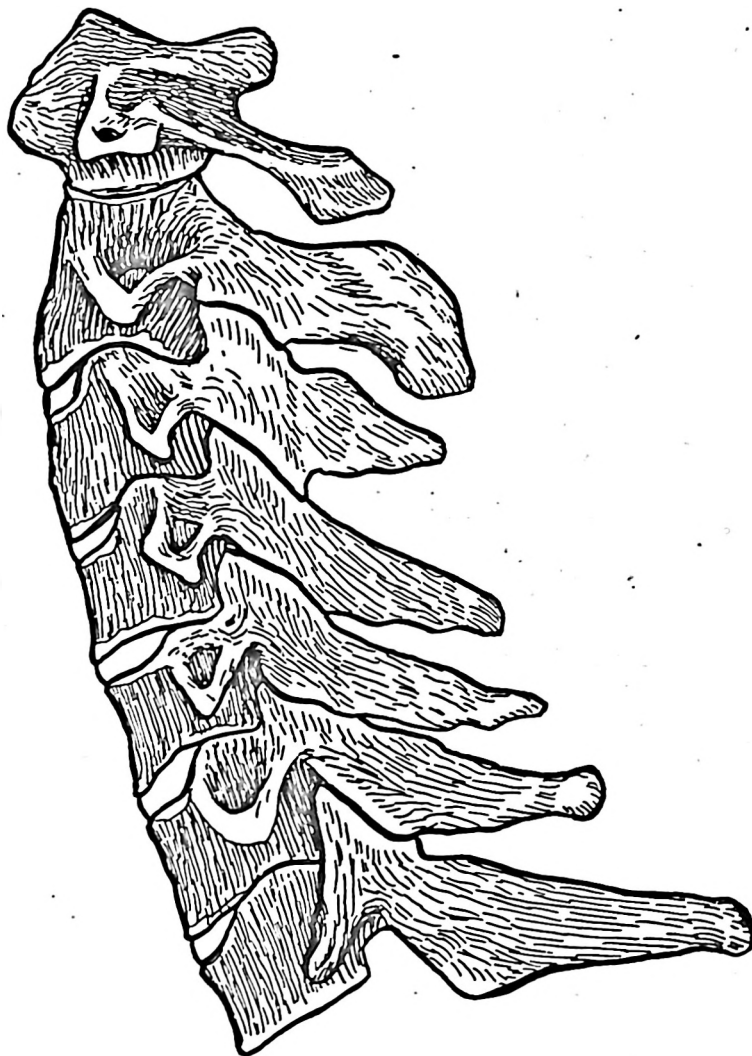


Fig. 11. Lateral View of the Cervical Region.

## The Cervical Region

Fig. 11.

For the purposes of study it has been found convenient to divide the spinal column into regions and name these regions according to the portion of the body through which that region passes. The first or uppermost division is called the Cervical Region from the word "Cervix," meaning "narrow or constricted part" and is so named because this region of the spine passes through that part of the human anatomy which is known as the neck. This division consists of seven segments of bone called vertebrae. The vertebrae in this region are the smallest and most delicately formed segments in the spine, and they are admirably adapted to the great mobility of this region.

All mammals, with few exceptions, have seven segments in the cervical region. The two-toed sloth is one exception, having only six, while the long-necked giraffe and the horse, in common with the short-necked hog and sheep have seven cervical vertebrae. In man the average length of the cervical region is about five inches, although, of course, this will vary slightly with different individuals.

The mobility in this region of the spine is greater than that of the other regions. The possible movement of the head is the result of the sum of the possible movement between these several segments. The anatomical construction of the cervical region is such as to interfere as little as possible with movement and still furnish adequate strength to carry the

weight of the head and provide ample protection to the spinal cord and other delicate parts. The cervical vertebrae are so arranged in the recent state as to form an anterior curve.

#### Differentiating Features.

##### Fig. 12.

The typical cervical vertebrae possess descriptive parts in common with all the segments of the other regions of the spinal column, but there are certain features of the descriptive parts which are found only in the cervical region and which differentiate these segments from the segments of the other regions of the vertebral column. These points are known as the Differentiating Features of the Cervical Region. These differentiating features are found on the bodies, the transverse processes and on the spinous processes. Fig. No. 10 is a schematic drawing which shows these differentiating features. It is made schematic so as to bring out clearly these points that the student may have little difficulty in locating them. The following outline will assist the memory in retaining these points:

1. The Bodies are lipped.
2. The Transverse Processes are pierced at their base by the Foramen Transversarium.
3. The Spinous Processes are bifid.

These differentiating features are found on all of the typical cervical vertebrae.

#### Function of the Lips.

The lips on the bodies of the cervical vertebrae are for the purpose of strengthening this region of the spine where a great variety of motion and great flexibility is required in turning the head in the different directions without the necessity of turning the entire body. Considering the plane of the

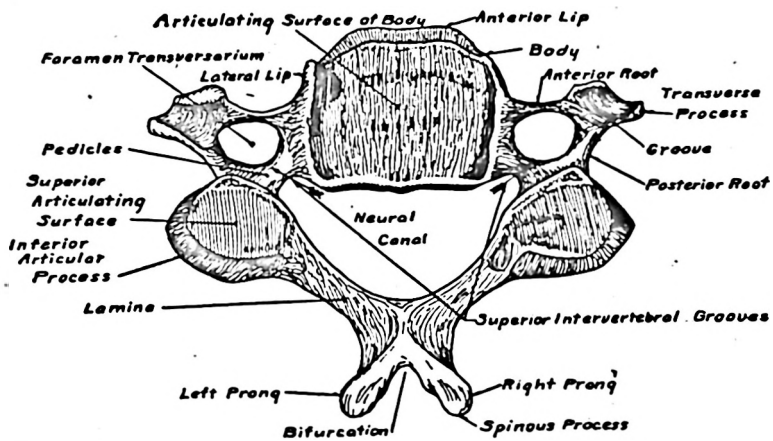


Fig. 12. Fourth Cervical Vertebra (Schematic).

articulating surfaces it can readily be seen that the burden of support, at least laterally and anteriorly, falls upon the bodies. In the dorsal region the ribs help to hold the vertebrae in proper position, while in the lumbar region the mammillary processes take care of this important function; but any such arrangement in the cervical region would greatly interfere with the movements of the neck, and if there were ribs in this region the symmetry of the body would be destroyed. Therefore, nature provided lips to assist the ligaments and muscles in holding these vertebrae in their proper places without interfering with the mobility of the neck.

#### **Foramen Transversarium.**

The transverse processes in the cervical region are formed by two roots, known as the anterior root, or costal process, and the posterior root. These two roots, when united at the extremity, form the transverse process, but leave an opening at the base between these two roots. This opening is known as the Foramen Transversarium. These openings or foramina form a somewhat interrupted canal for the transmission and protection of the vertebral artery and its accompanying veins. This artery, as a rule, does not pass through the foramen transversarium of the seventh cervical vertebra, but enters that of the sixth and thence upward through all the foramina of the other cervical vertebrae. Thus an adequate protection is provided for this important artery as it passes up the side of the neck to the brain. Otherwise it would be very much exposed to injury.

#### **Bifid Spinous Processes.**

The spinous processes of the cervical vertebrae are all bifid except the seventh and sometimes the sixth. While the

spinous processes in other regions of the spine may sometimes be bifid, yet the bifurcation is quite different in appearance and the student would never confuse a segment from another region of the spine with those of the cervical region merely because the spinous process happened to be bifid. Occasionally a lumbar spinous process is bifid and the spinous processes in the lower dorsal region may also present this peculiarity, but these conditions are relatively rare. The bifid spinous processes must not be confused with Spina Bifida, which is a pathological condition. A bifid spinous process is never pathological, although it may be a peculiarity it would not result in an inco-ordination. There never has been any special reasons given for the spinous processes in the cervical region being bifid, or any particular function accorded them. It might be stated, however, that they do increase the area for the attachment of ligaments and the bifid spinous processes are quite in keeping with the general appearance of the cervical vertebrae.

### The Peculiar Cervical Vertebrae

In the different regions of the spine there are certain vertebrae which are spoken of as being typical and others as being peculiar. By a typical vertebra we mean a vertebra that has all the descriptive points in common with the other vertebrae of that region, while a peculiar vertebra is, as the term would indicate, a vertebra that has certain points that are peculiar to that particular vertebra and not found on the other segments of that region.

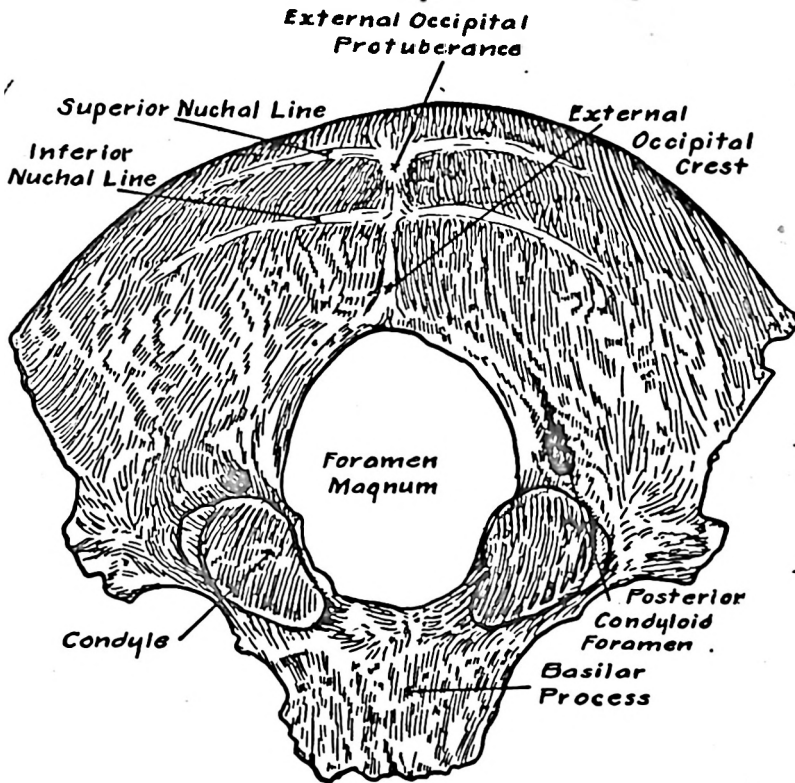
In the cervical region there are three peculiar and four typical vertebrae, unless the third is considered peculiar, which would reverse the figures, giving four peculiar and only three typical vertebrae. The third cervical is listed by most anat-

omists as peculiar. Its peculiarity consists in it being the smallest segment in the region and this makes its peculiarity only comparative. While the third cervical is always the smallest segment in this region of a given specimen, it might be larger than the fourth cervical of another specimen. Therefore, in our work we do not consider the third cervical vertebra as a peculiar vertebra since it has no descriptive parts which differ from the typical vertebrae. The peculiar cervical vertebrae are:

1. Atlas.
2. Axis.
3. Seventh Cervical.

These peculiar vertebrae are thoroughly described and their peculiarities explained in the chapter on peculiar cervical vertebrae. The following outline will show why these segments are called peculiar and why they do not present the differentiating features of the other cervical vertebrae:

1. The Atlas is devoid of a body and a spinous process, therefore it has no lips or bifid spinous process.
2. The superior surface of the body of the axis has no lips since this surface supports the odontoid process.
3. The spinous process of the seventh cervical vertebra is not bifid and the inferior surface of the body has no lip. This segment takes on the characteristics of the dorsal region as well as the cervical. The spinous process and the inferior surface of the body are typical of the dorsal vertebrae.



*Inferior view of Occipital Bone*

Fig. 13. Inferior Surface of the Occipital Bone.

The above figure shows the inferior surface of the occipital bone. This illustration is used, not for the purpose of studying the occipital bone, but for the purpose of showing the Foramen Magnum, the opening through which the spinal cord passes from the cranium; also for the purpose of showing the articulating surfaces of the condyles of the occiput which articulate with the superior articulating surfaces of the atlas.

The superior and inferior curved lines are clearly shown, also the external occipital protuberance. From this illustration, which is a photograph of a specimen, over which the pen line drawing was made, the student may get an idea of the relationship between the occipital bone and the atlas.

## The Atlas

Figs. 14-15.

The Atlas, which is the first cervical vertebra, is given the generic title of Atlas Place, the abbreviation being At. P.

Atlas, in Greek mythology, was the Titan who fought against the gods and for this he was condemned by Zeus, the chief of the gods, to carry on his shoulders the vault of heaven. Hence the ancients called the first cervical vertebra the "Atlas," from the fact that it supports the globe or head.

This segment is entirely different from the other segments of the spine. It is given as one of the peculiar cervical vertebrae and is the most peculiar in the entire spinal column from the fact that the construction is entirely different. The Atlas consists merely of a bony ring having neither body nor spinous process and the neural arch instead of being formed by the pedicles and laminae, as in the other vertebrae, is formed by a solid ring of bone called the posterior arch of the Atlas. The descriptive parts of the Atlas are:

Two lateral masses.	One Anterior Arch.
Four Articular Processes.	One Posterior Arch.
Two Transverse Processes.	

It is desirous that the student not only learn the names of these descriptive parts but also their relative position with respect to each other for the purpose of obtaining a perfect mental picture. The accompanying cuts will be found to be of special aid to the memory in this respect.

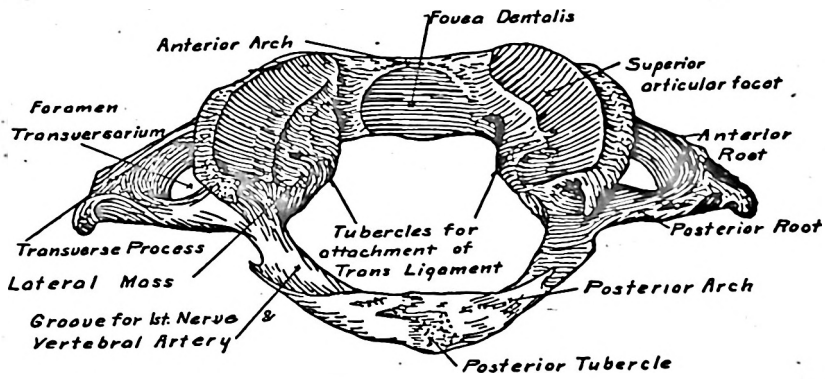


Fig. 14. Posterior Superior View of the Atlas.

### **The Lateral Masses**

The two lateral masses are composed of spongy bone tissue and form the principal bulk of the Atlas. They support the entire weight of the head. They are irregular in shape, six sided and present six surfaces for description. These lateral masses are located in such a position with reference to each other that there is one on either side of the neural ring, each forming one-fifth of the ring of the Atlas. They converge at the anterior and diverge at the posterior.

#### **Superior and Inferior Surfaces.**

It is upon the superior and inferior surfaces of the lateral masses that the four articular processes are located. These processes cover the entire superior and inferior surfaces.

#### **Anterior Surfaces.**

The ends of the anterior arch of the Atlas are firmly attached to the anterior surface of the lateral masses.

#### **Posterior Surfaces.**

The posterior surfaces of the lateral masses give attachment to the ends of the posterior arch of the Atlas. A small portion of the upper part of the posterior surface helps to form the anterior wall of the foramen for the passage of the first pair of spinal nerves.

#### **Exterior or Lateral Surfaces.**

Arising at the juncture of the anterior arch with the lateral masses on either side and projecting backwards are two processes of bone known as the costal processes or anterior roots of the transverse processes of the Atlas. Just posterior to these and at the junction of the posterior arch

with the lateral masses on either side projecting laterally and slightly forward are two processes of bone known as the posterior roots of the transverse processes which unite with the anterior roots at their extremity to form the transverse processes of the Atlas. Between the two roots and the distal surface of the lateral mass, which forms the medial wall, is the foramen transversarium.

#### **Interior or Medial Surfaces.**

The interior or medial surfaces are very rough and irregular. On this surface on either lateral mass is found a small tubercle placed a little to the anterior of the center and about midway between the superior and inferior articular processes. This tubercle gives attachment to the transverse ligament of the Atlas which stretches across the ring dividing it into two unequal parts and holding the Odontoid process in firm contact with the Fovea Dentalis on the posterior surface of the anterior arch of the Atlas. In studying the Atlas one gets the impression of the body having been divided antero-posteriorly in the center. The two lateral halves being pushed aside, the Odontoid process projects between them to form a pivot upon which the head may rotate. The rotation of the head takes place between the Atlas and Axis around the Odontoid process, the nodding being between the Atlas and Occiput.

The ring of the Atlas is divided into two unequal parts by the transverse ligament. The anterior portion of this ring is the smaller of the two and allows for the passage of the Odontoid process. The posterior portion transmits the spinal cord and its coverings and is called the Neural ring of the Atlas. This neural ring is formed by the posterior arch of the Atlas and the transverse ligament.

### Superior Articular Processes

The lateral masses support the four articular processes, two superior and two inferior. The superior articular processes are large, oval in shape and deeply concave. The surfaces look upward and slightly inward toward the median line. They articulate with the articulating surfaces on the condyles of the occiput. In examining different specimens it will be observed that seldom, if ever, are two surfaces identically the same. Seldom are the two surfaces alike on the same atlas. Often the surface on one lateral mass will be entirely divided by a transverse groove forming two distinct articulating surfaces on one articular process, although this groove may be nothing more than a slight notch or depression in the side of the articulating surfaces. These differences in the surfaces of the superior articular processes account for the different manner in which different people carry the head. For no two people carry their heads exactly the same. Some anatomists speak of the superior articulating processes as being cup-shaped on account of being so deeply concave. Cunningham's anatomy calls the superior articulating processes the Fovea Articularis Superior, while Mrs. Palmer speaks of them as the Superior Articulating Processes.

### Inferior Articular Processes

The inferior articular processes of the Atlas are more constant in size and the articulating surfaces more uniform in shape than the superior ones. They cover the entire inferior surfaces of the lateral masses. The inferior articular surfaces are circular in shape and slightly concave from side to side. From before backward they are somewhat flat. They look downward and slightly toward the medial line in such a

manner as to permit a free rotation upon the Axis. At this point the student should carefully observe that the superior and inferior articular processes of the Atlas and the superior articular process of the Axis are placed very differently with reference to the spinal cord and the intervertebral foramina than in the balance of the spine. These articular processes are placed anterior to the spinal cord and the intervertebral foramina, while in the balance of the spinal column the articular processes are all found posterior to the spinal cord and the intervertebral foramina. It can readily be seen that this is a logical arrangement from a mechanical standpoint in that it permits the weight of the head to be transmitted to the solid column formed by the bodies of the vertebrae below instead of falling on the neural arches, as would be the case if the articular processes were arranged so as to be directly superior to the other articular processes of the spinal column.

### Posterior Arch of the Atlas

The posterior arch of the Atlas, or Arcus Posterior, is more delicately formed than the anterior arch, but is longer, forming two-fifths of the ring. It is composed of solid, compact bone and is heavier at the center than at the extremities, tapering from the center toward the lateral masses, to which it is attached at either end, uniting the lateral masses at the posterior and forming the posterior wall of the neural ring of the Atlas. The posterior arch of the Atlas forms the neural arch and takes the place of the pedicles and laminae of the other vertebrae. The anterior surface of the posterior arch is concave from side to side while the posterior surface is convex from side to side.

The ends of the posterior arch which are attached to the lateral masses are beveled on the superior and inferior sur-

faces. These depressions in the superior and inferior surfaces, which are called the intervertebral grooves, help to form the foramina for the passage of the first and second pairs of spinal nerves.

#### **The Anterior Surface of the Posterior Arch.**

There are no points for description on the anterior surface of the posterior arch of the Atlas, it being merely a smooth surface concave from side to side and forming the posterior osseous wall for the neural ring of the Atlas. This surface is shown in Fig. 15.

#### **The Posterior Surface of the Posterior Arch.**

On the posterior surface of the posterior arch will be found a small tubercle in the median line which is called the posterior tubercle of the Atlas and is analogous to the spinous process of the other vertebrae. The Ligamentum Nuchae is attached to this tubercle by means of an aponeurosis. It is obviously more fitting that there should be only a small tubercle here instead of a spinous process since a long process would interfere very much with the movements of the head because of the close proximity of the occipital bone.

#### **Anterior Arch of the Atlas—Fig. 15.**

Arising from the anterior and medial surface of the lateral masses is an arch of bone called the anterior arch of the Atlas, or arcus anterior, which unites the lateral masses in front. It is composed of solid, compact bone, being thicker at the center than at the extremities. It is convex from side to side on the anterior surface and concave from side to side on the posterior surface. The anterior arch forms one-fifth of the ring of the Atlas and completes the ring at the anterior.

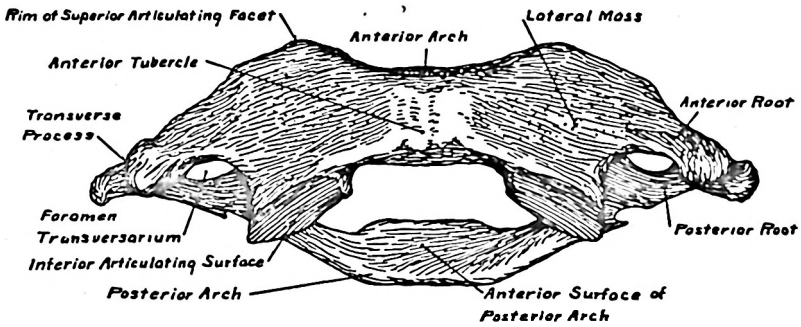


Fig. 15. Anterior Inferior View of the Atlas.

**Anterior Surface of the Anterior Arch.**

On the anterior surface in the medial line is a small tubercle called the Anterior Tubercle of the Atlas or Tuberculus Anterior, for the attachment of the Longus Colli Muscle.

**Posterior Surface of the Anterior Arch.**

On the opposite side from the Tuberculus Anterior in the center of the posterior surface is a small round, smooth depression called the Fovea Dentalis or Circular Facet, which is the articulating surface for the Odontoid process of the Axis (Fig. 14). The Odontoid process is held in place by the Transverse Ligament of the Atlas, which stretches across from one lateral mass to the other and is in apposition with the posterior surface of the Odontoid process at the posterior. The ring formed by the transverse ligament and the anterior arch, which transmits the Odontoid process, is known as the Anterior ring of the Atlas.

**The Intervertebral Foramina of the Atlas**

The grooves formed by the depression in the superior and inferior surfaces of the posterior arch are, in the recent state, converted into intervertebral foramina by the ligaments attached to these parts. The posterior Occipito-Atlantal ligament is attached to the posterior superior surface of the posterior arch and extends up to this intervertebral groove. Then instead of being attached to the floor of the groove it stretches across and is attached to the overhanging tubercle on the posterior margin of the superior articular processes. Thus this groove is converted into a foramen, the floor of which is formed by the groove in the superior surface of the posterior arch and the roof by the fibers of the ligament. Occasionally the fibers of this ligament ossify, forming a spiculae of bone

which together with the extra development of the tubercle of the articular process forms a permanent bony foramen which is observed in many specimens. This pair of intervertebral foramina permits the transmission of the first pair of spinal nerves and also the vertebral artery. The foramina for the passage of the second pair of nerves are formed in practically the same way by the intervertebral groove in the inferior surfaces of the posterior arch. Here we find slight grooves or depressions in the superior surfaces of the laminae of the axis. These are formed into foramina by the Posterior Atlanto-Axial ligament. Special notice should be taken of the fact that the foramina for the passage of the first and second pairs of spinal nerves are found posterior to the articular processes while in the balance of the spine they are anterior to the articular processes. It is necessary for the student to understand not only how the intervertebral foramina are formed, but also where they are located with reference to those parts of the vertebrae which can be palpated. This information is absolutely indispensable if the student is to make use of the art of nerve tracing, for as has already been demonstrated, nerve tracing is essential in Chiropractic analysis.

#### Locating the Intervertebral Foramina by Palpation.

Since the atlas has no spinous process the transverse processes must be palpated and used as points of comparisons with surrounding tissues to determine the direction in which it is subluxated, therefore it is best to locate the intervertebral foramina superior to the atlas with relation to transverse processes. Although they may be located with reference to the tubercle on the posterior arch of the Atlas by drawing an imaginary line from the external Occipital protuberance

on the Occipital bone to the center of the bifurcation of the spinous process of the Axis. The intervertebral foramina superior to the atlas will be found just back of the transverse processes and toward the median line of the neck about three-fourths of an inch from the tip of the transverse process and just a little superior to a horizontal plane with the superior border of the posterior arch. The knowledge of the location of the intervertebral foramina enables the Chiropractor to locate the tender nerves superior to the Atlas.

### Transverse Processes of the Atlas

The transverse processes of the atlas are typical of the cervical region. They arise by two roots called the anterior and posterior roots. The anterior root arises from the junction of the anterior arch with the lateral masses. The posterior root arises from the junction of the posterior arch with the lateral masses. This posterior root, which is the transverse process proper, seems to be a continuation laterally and slightly forward of the posterior arch while the anterior root, also known as the Costal Process from the fact that it is analogous to the rib in the dorsal region, projects laterally and slightly backwards. These two roots meet at their extremities, the tubercles fusing and forming one mass with an opening between them at their base. This opening is called the Foramen Transversarium and is for the transmission and protection of the vertebral artery and its accompanying veins. The ligaments and muscles attached to these transverse processes assist in rotating the head. The atlas has no spinous process for the Chiropractor to palpate so the transverse processes are found very convenient for this purpose.

### Ossification of the Atlas

The development of the atlas is in cartilage and takes place from two principal centers of ossification, one on either side, from which all the descriptive parts of the atlas are developed except the anterior arch and a portion of the superior articular processes, which are developed from the center and described as varying from single to double centers of ossification.

The two centers of ossification from which the posterior arch, the transverse processes, and lateral masses are developed, make their appearance between the seventh and tenth weeks of foetal life. But the union of the two lateral halves at the center of the posterior arch does not take place until after birth. Some authors claim this union takes place as late as the third year. The ossification of the transverse processes is not completed until later.

According to some authors the ossification of the anterior arch and the anterior portion of the superior articular processes begins during the first year after birth. But the union of the transverse processes with the lateral masses is not complete until the sixth to the eighth year. With these facts before us the question is raised as to the possibility as well as the advisability of adjusting the atlas of the child before the processes of ossification are complete. It has been demonstrated that it is possible to successfully adjust the atlas of even the infant, for the cartilage in which the ossification takes place is sufficiently firm to allow for the application for sufficient recoil to move the subluxated atlas and accomplish the desired end without the slightest danger of injury to the cartilaginous portion of the developing Atlas. It is needless to state, however, that care must be exercised in adjusting

the vertebrae of a child, not so much because of the process of ossification which is going on in the vertebrae, but more particularly because of the fact that the segments are so small and it is more or less difficult but not at all impossible to get a point of contact.

## The Axis or Epistropheus

Fig. 16-17.

The second cervical vertebra is called the Axis because it forms a pivot upon which the head rotates. This rotation is accomplished by means of the arrangement of the articulation between the Atlas and the Axis.

The Axis, like the Atlas, is a peculiar cervical vertebra, the peculiarity lying in the Odontoid Process or Dens, which is a tooth-like process of bone projecting upward from the superior surface of the body; and the fact that the superior articular processes are not at the junction of the pedicles with laminae but are large oval shaped processes which are supported by the superior surface of the body and cover the entire superior surface of the pedicles extending outward over the root of the transverse process. Aside from the Odontoid process the Axis has the same descriptive parts as a typical cervical vertebra.

### Odontoid Process

The Odontoid Process or Dens is so named because it resembles a tooth. It practically covers the superior surface of the body of the Axis from which it projects upward into the anterior ring of the Atlas. There is a circular articulating surface on the anterior which articulates with the Fovea Dentalis on the posterior surface of the anterior arch of the Atlas. On the posterior surface there is a slight transverse groove across which the transverse ligament of the Atlas

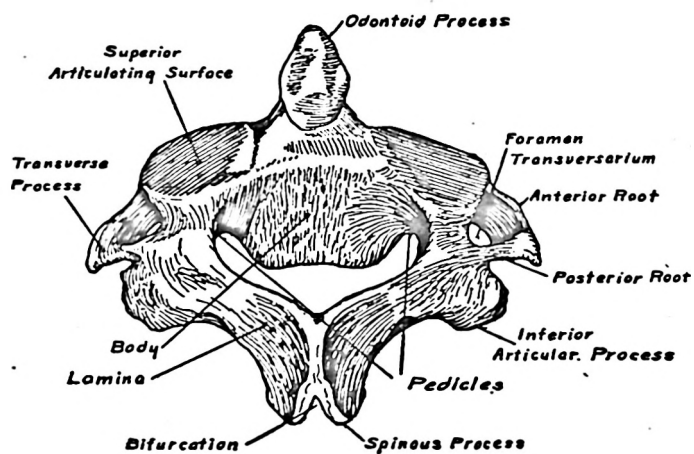


Fig. 16. Posterior Superior View of the Axis.

is stretched. This ligament holds the Odontoid process in firm contact with the Fovea Dentalis.

The Odontoid Process ends in a blunt extremity at the apex to which is attached the middle Odontoid ligament. On the side near the top there are rough surfaces for the attachment of the two check or Alar ligaments also called the lateral Odontoid Ligaments.

The Odontoid process is considered by some as the detached body of the Atlas being attached to the body of the Axis. If the Atlas is subluxated toward the inferior, the Odontoid process will be thrown posterior and produce pressure upon the posterior fibers of the spinal cord. The Transverse ligament plays a very important part in holding the Axis in place and lessening the possibility of a subluxation in this direction.

### Body of Axis

The body of the Axis is somewhat cylindrical in shape, the lateral width being greater than the Antero-posterior width and is deeper in front than behind. It is composed of a mass of spongy bone tissue, the outer layer of which is formed of solid compact bone pierced by many small openings or foramina for the passage of nutrient vessels such as blood vessels, nerves and the lymphatics.

#### Anterior Surfaces of the Body.

Generally speaking, we can say that the anterior surface of the body of the axis is triangular in shape with a rough surface. In the median line there is a longitudinal ridge which begins at the base of the Odontoid process and proceeds downward extending over the inferior margin of the body forming a projection known as the Anterior Lip of the Axis.

This anterior lip extends down over the superior surface of the intervertebral disc between the Axis and the third cervical vertebrae. There is a depression in the anterior margin of the superior surface of the body of the third cervical vertebra into which the anterior lip of the Axis fits when the head is bent forward and downward. The function of this anterior lip of the Axis is to assist in holding the Axis in proper apposition with the Atlas and third cervical. This lip, together with the transverse ligament of the Atlas, especially helps to prevent the Axis from being subluxated towards the posterior.

#### **The Posterior Surface of the Body.**

The posterior surface of the body of the Axis is slightly wider at the inferior than at the superior; it is straight from above downward, slightly concave from side to side.

The foramina in this surface are comparatively large. There is one depression near the center which is especially large. In this depression are a number of small foramina through which the large veins which drain the body of the Axis are transmitted. The posterior surface of the body forms the anterior wall of the neural ring of the Axis.

#### **Inferior Surface of Body.**

The inferior surface of the body of the Axis is concave Antero-Posterior, this concavity being deepened by the presence of the anterior lip. On either side, laterally, will be found a small depression in the lateral margin of this inferior surface. These depressions make the inferior surface slightly concave from side to side. They receive the lateral lips of the vertebrae next below when the head is bent from side to side. Around the margin of this inferior surface and attached firmly to it will be found the Epiphyseal plate which is a layer of

solid compact bone tissue. This plate in early life is cartilage which is hyaline in nature and which later ossifies from a separate center of ossification and becomes a part of the body, thereby giving a very firm attachment to the intervertebral discs. In early life it is impossible to separate the intervertebral discs from the epiphyseal cartilage. The white fibers of the intervertebral discs intermingle with the hyaline cartilage, and as this cartilage ossifies from a center of ossification of its own, the fibers of the intervertebral discs are very firmly held. And as the epiphyseal plate becomes attached to the body it can readily be seen what a firm attachment is made between the body of the vertebrae and the intervertebral discs.

#### **Lateral Surface of Body.**

The lateral aspect of the body of the Axis gives rise to the costal process or anterior roots of the transverse process. This surface also assists in forming the medial wall of the foramen transversarium.

### **Pedicles**

The Pedicles of the Axis, also called the roots of the vertebral arches, are two short, comparatively heavy processes of bone tissue. They are attached to the posterior half of the lateral aspect of the body and project backward and slightly outward.

The pedicles of the Axis are slightly different from those of the other vertebrae, for there is no intervertebral notch in the superior surface, but the pedicles are covered entirely by the superior articular processes. However, in the inferior surface of the pedicles there is found a deep groove which is known as the intervertebral notch. This notch in the in-

ferior surface of the pedicles of the Axis, together with the notch in the superior surface of the pedicles of the third cervical vertebra, forms the foramina for the passage of the third pair of nerves.

### The Intervertebral Foramina

The intervertebral foramina superior to the axis are formed between the superior surface of the laminae of the axis and the inferior surface of the posterior arch of the atlas. They are formed by the grooves in the superior surface of the laminae just posterior to the articular processes. The grooves are converted into foramina by the attachment of the posterior atlanto-axial ligament which is attached to the posterior superior surface of the laminae and the posterior inferior surface of the posterior arch of the atlas and arches across the groove.

With reference to the spinous process of the Axis these foramina are located about one-half inch above a horizontal plane passing through the tip of the spinous process and approximately one inch laterally from the center of the bifurcation, forming an angle of about  $22^{\circ}$ .

### The Laminae

Proceeding backward from the pedicles are the laminae. These are two flat processes of bone, but with the Axis they are much stronger and less flattened than the balance of the cervical region. They are prismic on cross section. These laminae are firmly attached to the pedicles and project backward, converging and meeting in the posterior median line completing the neural arch at the posterior and fusing together to form the spinous process. Just posterior to the

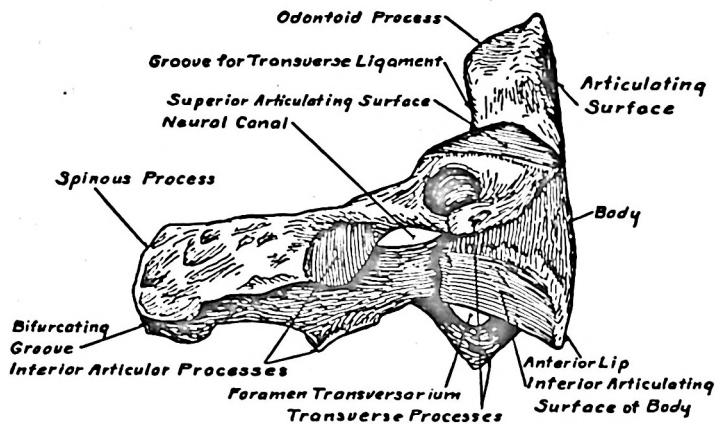


Fig. 17. Lateral Inferior View of the Axis.

superior articular processes there are small grooves or depressions in the laminae which mark the exit of the second pair of spinal nerves from the vertebral canal.

### Spinous Process

The spinous process of the Axis is a comparatively heavy, thorn-like process of bone found in the posterior median line and formed by the junction of the laminae. It is deeply bifid with a deep groove in its under surface. This bifurcation is sometimes misleading to the palpator for the prongs are not always of equal length and in this event an impression of laterality would be given if the prongs alone would be palpated, therefore, instead of palpating the prongs, an effort should be made to feel the center of the bifurcation for, as a rule, the center of the bifurcation is in the center of the vertebrae. Occasionally a bad spinous process will be found in this region. But here our palpation can be verified by our nerve tracing. If the center of the bifurcation is in the median line we can be reasonably certain that the vertebra is not subluxated.

### Transverse Processes

The transverse processes of the Axis are two short foot-like processes of bone found on either side of the neural arch pointing laterally and slightly downward, each arising by two roots. The anterior root arises from the superior portion of the lateral portion of the body, and projects laterally, downwardly and posteriorly. This anterior root is also called the costal process, being homologous to the rib in the dorsal region.

The posterior root or the transverse process proper arises at the junction of the pedicles with the laminae and projects

downwardly, laterally and slightly towards the anterior. These two roots meet at their extremities and unite, leaving an opening or foramen at the base. Hence, we say that the transverse processes in the cervical region are pierced at their base by a foramen. Extending slightly over the base of the transverse process of the Axis are the superior articular processes.

### Articular Processes

It is usually stated that the Axis presents six articulations but in reality there are seven. They are the articulation between the Odontoid process and the anterior arch of the atlas, the articulation between the inferior surfaces of the body of the Axis, and the superior surface of the body of the third cervical, the four articulations between the vertebral arches, the two superior and the two inferior. There is also an articulation by means of ligaments only, between the Dens and the Occipital bone. But when speaking of the articulations they are usually referred to as being four in number, two superior and two inferior. The superior articulating processes are supported by a portion of the body. They are large and somewhat oval in shape. The surfaces are practically flat. There is, however, a convexity from before backwards and it is directed upward and slightly laterally.

## The Typical Cervical Vertebrae

Fig. 18-19.

The Third, Fourth, Fifth and Sixth cervical vertebrae are typical cervical vertebrae. They are so called because they all have the same descriptive parts, but this does not necessarily mean that these descriptive parts are all identically the same. As a matter of fact they are not at all the same.

The descriptive parts of a typical cervical vertebra are the same as the descriptive parts of a typical vertebra of the spine with the addition of the lips on the bodies. The descriptive parts are:

One Body.	Two Laminae.
Three Lips.	Two Transverse Processes.
Two Pedicles.	Four Articular Processes.
One Spinous Process.	

### The Body

In describing the body of a typical cervical vertebra we will repeat some of the things that were said about the body of the axis, for the bodies of the different vertebrae have much in common, but there are many points for discussion on the bodies of these vertebrae that are not found on the body of the axis.

The body of a typical cervical vertebra is composed of a mass of spongy bone tissue, the outer layer of which is of more solid compact bone perforated by many small openings

called foramina. The transverse diameter of the bodies of this region is greater than the anterior-posterior, making them oblong in shape, while the vertical diameter is less than the transverse diameter.

#### **Superior Surface.**

The superior surface of the body of a typical cervical vertebra is concave transversely or from side to side. This concavity is deepened by the lateral lips. Antero-posteriorly, or from before backward, this superior surface is not so deeply concave because of the depression in the anterior margins which receive the anterior lip of the vertebra next above when the head is bent forward and downward. This surface slopes slightly downward from the posterior toward the anterior.

#### **Inferior Surface.**

The inferior surface of the body of a typical cervical vertebra is deeply concave antero-posteriorly, or from before backward. The concavity is deepened by the anterior lip. Laterally, or from side to side, the concavity is much less and in the lateral margins are found two depressions which receive the lateral lips of the vertebra next below when the head is bent laterally.

There is a layer, or ring of solid compact bone on the inferior surface which forms the epiphyseal plate, but these epiphyseal plates are not very distinct in the cervical region because of the irregularity caused by the lips on the superior and inferior surfaces.

#### **Anterior Surface.**

The anterior surfaces of the bodies of the typical cervical vertebrae will be found to be somewhat flattened in the median line, although some of them present quite a well defined

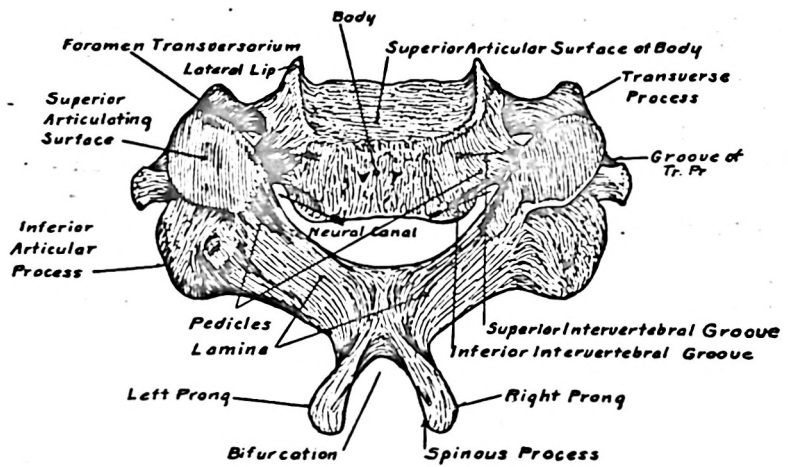


Fig. 18. Typical Cervical Vertebra (4th Cervical).

longitudinal ridge. On the lateral aspect the bodies are concave from above downward. From side to side the anterior surfaces are convex. There are many small openings in the anterior surface for the passage of nutrient vessels to the body.

#### **Posterior Surface.**

The posterior surface of the body of a vertebra forms the anterior wall of the neural ring. In the typical cervical region this surface is straight from above downward and from side to side it is very slightly concave, although some authors speak of the posterior surface of the bodies in the cervical region as being slightly convex. But from a very careful study of a great many segments of this region I am convinced that this apparent convexity exists, because the pedicles in the cervical region are not attached to the posterior surface as in the other regions of the spine but are attached to the lateral aspects of the body at the posterior. This causes the body to project slightly anteriorly into the neural ring.

The foramina in the posterior surface of the bodies of these vertebrae are quite large, especially one near the center of the posterior surface.

#### **Lateral Surface.**

The lateral aspects of the bodies of the cervical vertebrae are straight from above downward and at the extreme posterior edge give attachment to the pedicles. The anterior root of the transverse process arises from the center of this lateral surface about midway between the superior and inferior margins. This surface also forms the medial wall of the Foramen Transversarium.

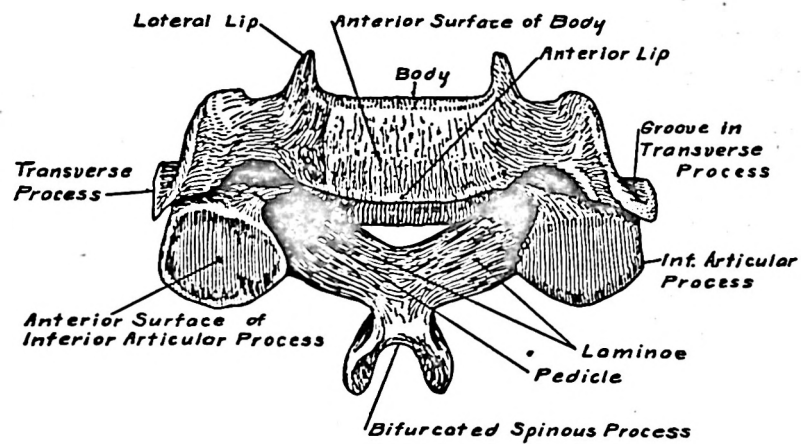


Fig. 19. Typical Cervical Vertebra—Anterior Inferior View (4th Cervical).

## The Lips

One of the differentiating features of the cervical vertebrae is the lips that are found on the bodies. There are three lips on the body of each typical cervical vertebra, two lateral lips and one anterior lip.

The two lateral lips are found on the superior surface of the body and are formed on either lateral margin; they project upward and overlap the intervertebral disc above. When the head is bent laterally these lateral lips are received into the depression in the margin of the inferior surface of the body of the vertebra next above.

These lateral lips are formed by the extension upward of the outer layer of solid compact bone which surrounds the cancellous bone tissue of the body of the vertebra. The epiphyseal plate follows the contour of the lateral lips.

The anterior lip is formed in the median line by a projection downward of the outer layer of solid compact bone tissue and it extends down over the anterior margin of the inferior surface overlapping the superior edge of the intervertebral disc below. When the head is bent forward the lip is received into the depression in the anterior margin of the superior surface of the vertebra below. The epiphyseal plate on the inferior surface follows the contour formed by the anterior lip.

The function of the lips in the cervical region is to strengthen this region of the spine. However, they do not interfere with the movements of the head. The ribs in the dorsal region assist in holding the vertebrae in the proper apposition with each other, but it would be quite out of keeping with the general shape of the body to have such an arrangement in the neck as any arrangement of this sort

would not allow for the free movements of the head which are quite necessary to the performance of man's duties in life. In the lumbar region the mammillary processes help to strengthen the region, but again, processes of this nature would be of no real value except with very large vertebrae and there being only the weight of the head to support by the cervical vertebrae we can see that such large segments are not needed. The lateral lips assist in preventing lateral subluxations while the anterior lips serve to strengthen the region from anterior to posterior.

### The Pedicles

Projecting backward from either side of the posterior surface of the body and slightly diverging are two short comparatively heavy processes of solid compact bone tissue called pedicles, so named because they are supposed to represent little feet. These pedicles are also called by the later authors the "roots of the vertebral arches."

The superior and inferior surfaces of the pedicles are quite deeply and equally notched by the superior and inferior intervertebral grooves. The inferior surface of the pedicle above forms the roof of the intervertebral foramen while the superior surface of the pedicle below forms the floor of this intervertebral foramen.

### Laminae

Joined firmly to and projecting backward from the pedicles are two flat, platelike processes of bone which, from their shape, are called laminae. The width of the laminae is about equal to the thickness of the body. The laminae project backward obliquely downward from the pedicles and

converge toward the median line and meet at their extremity, completing the neural arch at the posterior. Thus, by uniting, they form the spinous process.

### Transverse Processes

The transverse processes of the typical cervical region are formed the same as those of the atlas and axis. They arise by two roots, an anterior root and a posterior root. The anterior root is composed of solid compact bone tissue and springs from the posterior portion of the lateral surface of the body and projects laterally, slightly downward and toward the posterior. This anterior root is also called the Costal Process because it is homologous with the rib in the thoracic region.

The posterior root, which is the transverse process proper, arises at the junction of the pedicles with the laminae and projects laterally, slightly forward and toward the inferior. These two roots each terminate in a small tubercle and are joined by a small process of bone at their extremity. This leaves an opening between them at their base. This opening is called the Foramen Transversarium. All the transverse processes in the cervical region are pierced at their base by this Foramen Transversarium. These two roots taken together constitute the transverse process in the cervical region. The small tubercles at the extremity of each root makes the transverse process bifid with a more or less well defined groove in the upper surface along which the spinal nerve trunk passes.

### Articular Processes

Aside from the superior and the inferior surfaces of the bodies of the vertebrae there are four articulating surfaces

supported by four well developed articular processes. These articular processes or zygapophyses arise at the junction of the pedicles and laminae. The articular surfaces are oblique to a horizontal plane at an angle of about  $40^{\circ}$ .

#### **Superior Articular Processes.**

The superior articular processes or pre-zygapophyses project upward from the junction of the pedicles with the laminae. The surface supported by these processes look toward the posterior and slightly upward.

#### **Inferior Articular Processes.**

The inferior articular processes or post-zygapophyses project downward from the junction of the pedicles with the laminae and become attached to the upper portion of the anterior surface of the laminae. The plane of the surfaces supported by these processes which are placed at an angle of about  $35^{\circ}$  to  $40^{\circ}$ , look toward the anterior and slightly downward, being just the opposite to that of the superior surfaces with which they articulate. These articular processes are all placed posterior to the intervertebral foramina.

### **Spinous Processes**

The spinous processes in the cervical region are all very much the same. They are not so typically "thorn-like" as they are in the dorsal region, although the word "spinous" means thorn-like. These spinous processes are located in the posterior median line and are formed by the junction of the laminae. They are very deeply bifid. This bifurcation is often misleading to the palpator as the prongs are not always of equal length, but the center of the bifurcation is usually in the center of the spinous process and as the spinous process

is in the center of the vertebra we find that the center of the bifurcation will be in the center of the vertebra. The function of the bifurcation in the spinous processes is to increase the area for the attachment of ligaments and muscles. The spinous processes in the cervical region point almost straight toward the posterior, being directed only slightly downward.

The ossification of the cervical vertebrae is accomplished very much the same as that of the axis. The center of ossification appears first in the vertebral arches on either side, extending, in the process of ossification, up to the superior articular processes, then to the transverse processes and the laminae, the process of ossification being completed in the spinous process after birth. The body is formed from two centers.

## A Comparative Study of the Typical Cervical Vertebrae

We will now consider the typical cervical vertebrae separately. While all the typical vertebrae of a region have all parts in common, yet we find that no two vertebrae are identically the same and there may be quite a variation in the descriptive parts.

### Third Cervical

The third cervical vertebra is sometimes given as a peculiar cervical vertebra and as a matter of fact it is so given by most anatomists. Its peculiarity, however, consists in its size and is therefore only comparative. The third cervical vertebra of one spine might be larger than the fourth cervical of another spine. There are no points of description on the third that are not found on the other cervical vertebrae, therefore in our work in this subject we do not mention it as a peculiar vertebra but list it among the typical segments of this region.

The third cervical is located in the deep concavity of the anterior curve in the cervical region. The spinous process is comparatively short and this makes it relatively difficult to feel in palpation. In some cases where the axis is inferior it may even be impossible to feel the spinous process of the third; but this need not disquiet us for if the third is sufficiently subluxated to cause trouble, the posteriority or laterality will bring it out sufficiently prominent to make it possible to palpate and list.

The laminae of the third cervical vertebra are shorter and more frail than those of the balance of this region and are easily fractured. All the descriptive parts are smaller than those of the other segments.

### Fourth Cervical Vertebra

This segment is a typical cervical vertebra but as before stated there are always points which differ somewhat from the other segments. There are no prominent differences, however, in connection with the fourth cervical. The spinous process of this vertebra is somewhat larger than that of the third but it is not quite as large as the spinous process of the fifth. The bifurcation in the spinous process is a little deeper and more pronounced than that in the spinous process of the third but in comparison with the fifth it is about the same. The prongs of the fifth are usually a little more irregular than those of the fourth. The body is a little larger than the body of the third but not quite as large as that of the fifth. The superior surface of the body of the fourth articulates with the inferior surface of the third cervical vertebra with the intervertebral disc between. The inferior surface of the fourth articulates with the superior surface of the body of the fifth cervical vertebra with the intervertebral disc between. The superior articular processes articulate with the inferior articular processes of the third and the inferior articular processes of the fourth with the superior ones of the fifth.

### Fifth Cervical Vertebra

The fifth cervical vertebra is somewhat larger than the fourth with which it articulates superiorly but is smaller than the sixth with which it articulates inferiorly.

The spinous process, although a little larger than that of the fourth, is not quite so deeply bifid. The prongs of the bifurcation, however, are likely to be more irregular than those of the fourth. This vertebra is relatively easy to palpate and is often found subluxated.

### Sixth Cervical Vertebra

This is the largest of the typical cervical vertebrae as would be readily supposed; all the descriptive parts are larger than those of the vertebra above.

It has already been stated that proceeding downward from the axis, the spinous processes become longer. Therefore we find the spinous process of the sixth to be the longest of the typical Cervical Vertebrae, although it is not as long as the spinous process of the seventh cervical vertebra.

The posterior root of the transverse process of the sixth projects more toward the posterior and the groove between the two roots through which the spinal nerve passes is much deeper than those above.

The sixth cervical vertebra is sometimes found to be a peculiar cervical in that the spinous process is not always bifid. It is sometimes found that the spinous process of this vertebra is more prominent than that of the seventh and in that event it is listed Vertebra Prominens instead of the seventh.

The sixth cervical vertebra articulates with the fifth cervical above and with the seventh cervical vertebra below.

## Peculiar Cervical Vertebrae

Fig. 20-21-22.

The peculiar cervical vertebrae are the Atlas or first cervical vertebra, the Axis or second cervical vertebra and the seventh. As has been stated, some anatomists list the third cervical as a peculiar cervical vertebra, but since the peculiarity consists only in the size of the vertebra we do not consider this sufficient to constitute it a peculiar segment. Therefore in our work we will consider the Peculiar Cervical Vertebrae to consist of the following:

The Atlas

The Axis

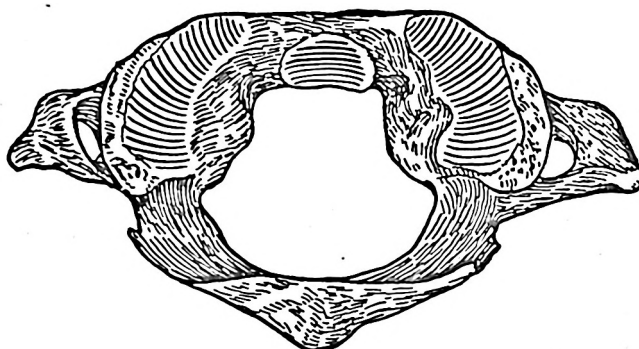
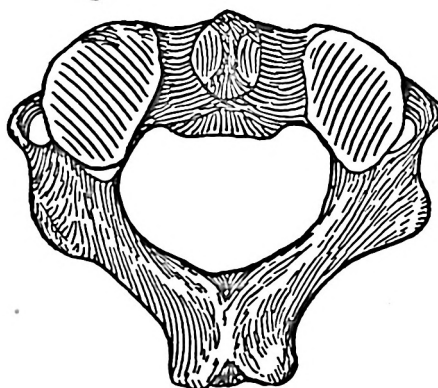
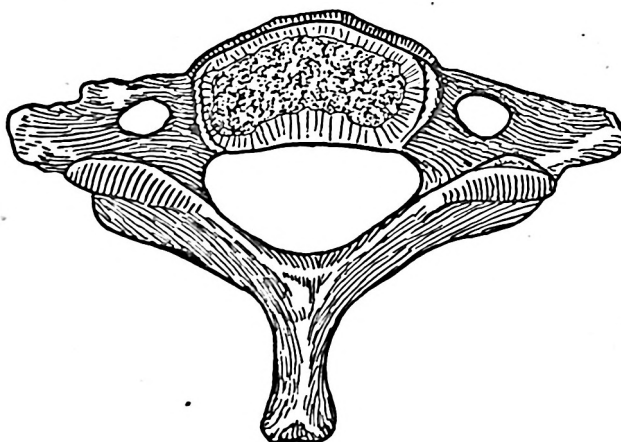
Seventh Cervical Vertebra

### Atlas.

The Atlas or first Cervical Vertebra has already been described, therefore we will not describe it in this chapter but will merely emphasize the peculiarities of this most peculiar segment in the spinal column.

The Atlas is composed of a ring of bone formed by the Anterior Arch of the Atlas, the Posterior Arch of the Atlas and the two lateral masses. It has none of the descriptive parts of a typical vertebra except the Transverse processes and the Articular Processes, but even at that the articular processes are very much different from those of a typical vertebra so that the only parts typical of the cervical region are the Transverse Processes.

The peculiarity then of the Atlas consists in it having no body, no pedicles, no laminae, no spinous process. The neural

*Atlas**Axis**7<sup>th</sup> Cervical Vertebra*

Figs. 20, 21, 22. The Peculiar Cervical Vertebrae.

arch, instead of being formed by the pedicles and laminae, as in a typical vertebra, is formed by an arch of bone called the posterior arch of the atlas. The neural ring, instead of being formed by the neural arch and the body of the vertebra, is formed by the posterior arch of the atlas and the Transverse

#### Ligament of the Atlas.

Another peculiarity of the atlas is the formation and location of the Intervertebral Foramina. Instead of being formed between the pedicles as in the balance of the spine, the intervertebral foramina superior to the atlas are formed by small depressions in the superior surface of the posterior arch and are located posterior to the articular processes instead of anterior as they are in all the vertebrae below the axis.

#### The Axis —A Peculiar Cervical Vertebra.

The most outstanding peculiarity of the Axis and the point which differentiates it from every other segment of the spine is the Dens, or Odontoid Process. This is a tooth-like process of bone which is always present; it projects upward from the superior surface of the body which supports it.

The superior articular processes are also different from those of a typical vertebra in that they are not formed at the junction of the pedicles with the laminae but are large, oval in shape, and are found to cover the entire superior surface of the pedicles extending up on to the lateral sides of the superior surface of the body and out over the roots of the transverse processes. The surfaces look toward the superior and slightly laterally, the plane being almost horizontal. The inferior articular processes are typical of the cervical region and are found at the junction of the pedicles with the laminae.

These two differences, the odontoid process and the articular processes give this segment a very different appearance from that of the other segments of this or any other region. In addition to these peculiarities we find that the spinous process is larger than the other cervical vertebrae and that it is very deeply bifid with a very deep groove in the under surface.

#### The Seventh Cervical Vertebra—A Peculiar Vertebra.

Figs. 22, 23, 24.

The seventh cervical vertebra is a transitional vertebra. By transitional vertebra is meant one lying between two different regions that are entirely distinctive in their features, and one that takes on the characteristics of both these regions. The peculiarity consists, therefore, in the fact that it has characteristics of both the cervical and dorsal regions. The point which makes it a peculiar vertebra is that the spinous process is not bifid but instead has a small tubercle at the apex.

This vertebra is also called VERTEBRA PROMINENS, because it is the most prominent vertebra at this point. This prominence is due partly to the length of the spinous process and partly because it is located at the beginning of the posterior curve in the Dorsal region.

Although the seventh cervical vertebra is listed as Vertebra Prominens this does not hold good in all cases for it is found that in some cases the sixth cervical will be more prominent than the seventh and in that event the sixth would be listed Vertebra Prominens (V. P.) instead of the seventh. The Vertebra Prominens is listed because it thus serves as a land mark in palpation.

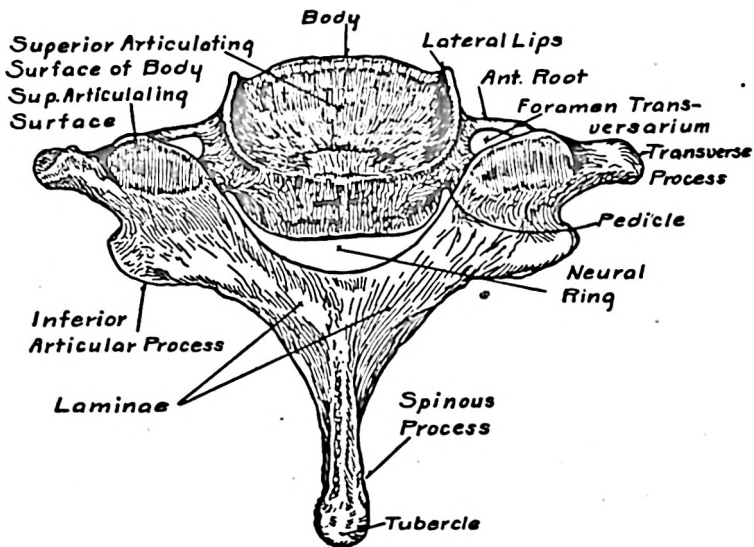


Fig. 23. Posterior Superior View of the Seventh Cervical Vertebra.

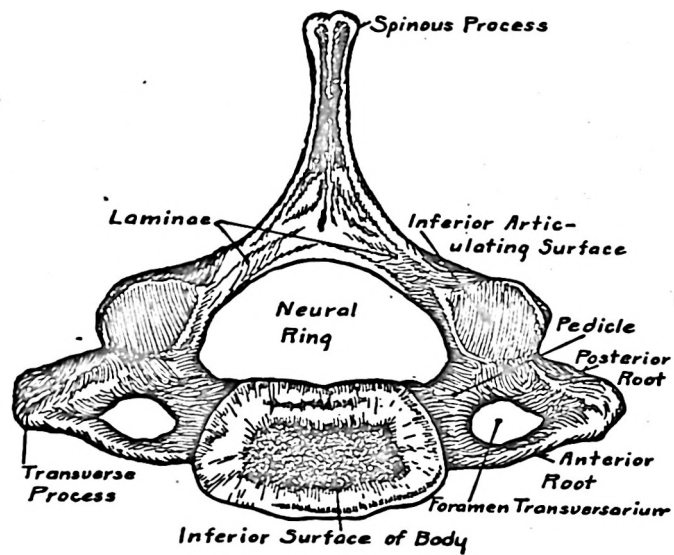


Fig. 24. Inferior View of the Seventh Cervical Vertebra.

### **The Body.**

The superior surface of the body of the seventh cervical vertebra is typical of the cervical region. The two lateral lips are found on this surface at the sides and there is also a small depression in the anterior superior margin. The inferior surface of the body is typical of the dorsal region. There is no anterior lip on the anterior inferior margin or depressions in the lateral inferior margins.

### **Transverse Processes.**

The transverse processes are the same as those of the cervical region, being pierced at their base by a foramen, although as a rule the vertebral artery does not pass through the Foramen Transversarium of the seventh cervical. Occasionally the anterior root of the transverse process does not unite with the posterior root but is developed into a cervical rib as shown in illustration Fig. 25. The anterior root of the transverse process is shorter than those of the other cervical vertebrae and projects more toward the posterior, the tubercle at the extremity being very small. This anterior root together with the bone connecting it with the posterior root is in a morphological plane with the neck of the ribs in the thoracic region. The posterior root projects more toward the posterior than the posterior roots of the vertebrae above. This brings the posterior root of the transverse process of the seventh cervical vertebra directly above the transverse process of the first dorsal vertebra.

### **Articular Processes.**

The articular processes are more nearly perpendicular than those of the cervical region but are about the same as those of the dorsal region. The spinous process is typical of the dorsal region.

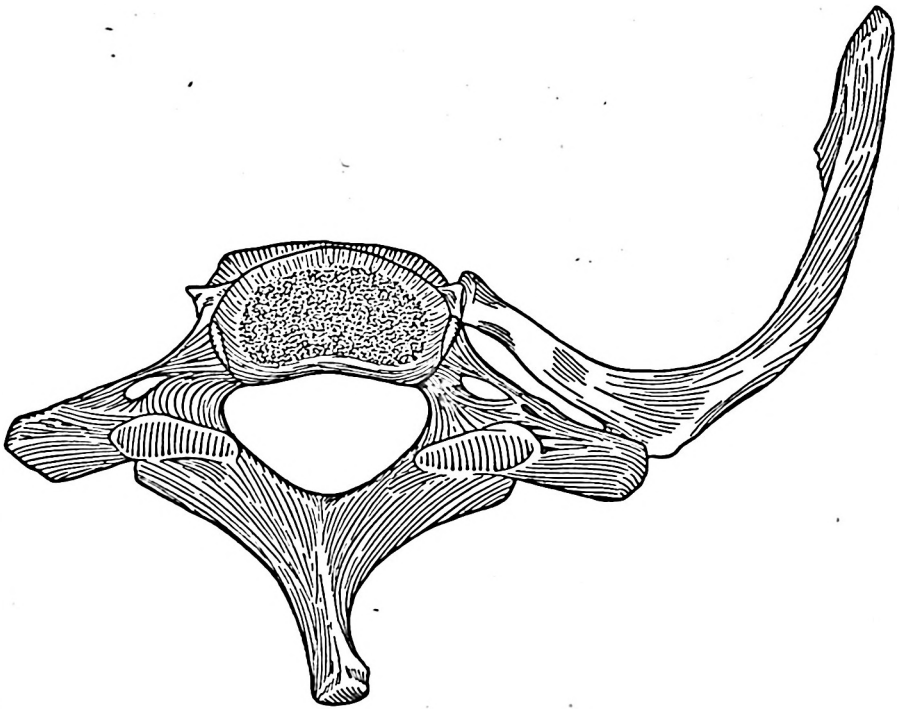


Fig. 25. Homologous Rib (7th Cervical Vertebra).

## Ossification of a Vertebra

The ossification of a vertebra takes place in cartilage and develops from three primary centers, one for the body and one on either side of the neural arch. Some authorities state that there are five accessory centers.

The greater portion of the body is developed from one center. Occasionally there will be a line found in the body of a vertebra that would indicate that it had been developed from two primary nuclei having coalesced, but ordinarily no such division can be discerned. It is concluded, therefore, that in the large majority of cases they are developed from a single nucleus.

The process of ossification begins in the lower thoracic region, appearing about the tenth week of foetal life. By the fifth month there will be found an ossific nodule in all the centra of the vertebrae except the coccyx.

A single center of ossification appears in each pedicle about the seventh week. From this center the posterior lateral portion of the bodies are formed, also the neural arch and the greater part of the processes supported by the neural arch. This process begins in the cervical region first. They first appear at a point not far from the superior articular processes and extend forward into the pedicles and the posterior lateral portion of the body, backward into the laminae and laterally into the transverse processes. The process of ossification continues to proceed toward the posterior until the laminae meet in the posterior median line and unite to

form the spinous process. This process is not completed until after birth, about the fifteenth month.

At birth the spinous processes are more or less cartilaginous. The vertebral arches, however, are very well formed. There is still a layer of cartilage on the superior and inferior surfaces of the bodies which are known as the epiphyseal plates. This cartilage ossifies later from a center of ossification of its own. It is also claimed that there is an epiphyseal end on the transverse processes and also on the spinous processes which ossify from separate ossific centers, beginning about the age of puberty and being completed about the eighteenth year.

The mammillary processes are developed from a separate center of ossification. The articulations in the lumbar region are the same as the dorsal region until the development of these mammillary processes. The costal processes of the sixth and the seventh cervical are also developed from a separate center. The costal process of the seventh cervical vertebra may develop into a large process resembling a rib and known as an homologous rib, a good illustration of which is shown in figure No. 25.

## The Intervertebral Foramina

The intervertebral foramen is of vital importance to the Chiropractor from the fact that the pressure upon the nerve which interferes with the transmission of mental impulses takes place at this point. It is, therefore, very necessary for the student to have a clear conception of the mechanism of the intervertebral foramen.

A Foramen is an opening through bone or between two adjacent bones through which nerves or other structures are transmitted. It may be a notch or a groove in a bone across which a ligament is stretched converting it into a foramen.

The word Intervertebral means between the vertebrae, hence the term Intervertebral Foramen means a window, or opening, or to be more scientific in our terminology, a foramen between two adjacent vertebrae.

An intervertebral foramen is an opening between the segments of the spine for the transmission of the spinal nerves. There are thirty-one pairs of these foramina. The first pair are formed between the occipital bone and the atlas and are called the suboccipital foramina. The floor is formed by the groove in the superior surface of the posterior arch of the atlas; the roof is formed by the fibers of the occipito-atlantal ligament which arches across this groove.

The Foramina superior to the atlas are formed differently from those of the other regions of the spine from the fact that the atlas has no pedicles. These foramina are found posterior to the articular processes.

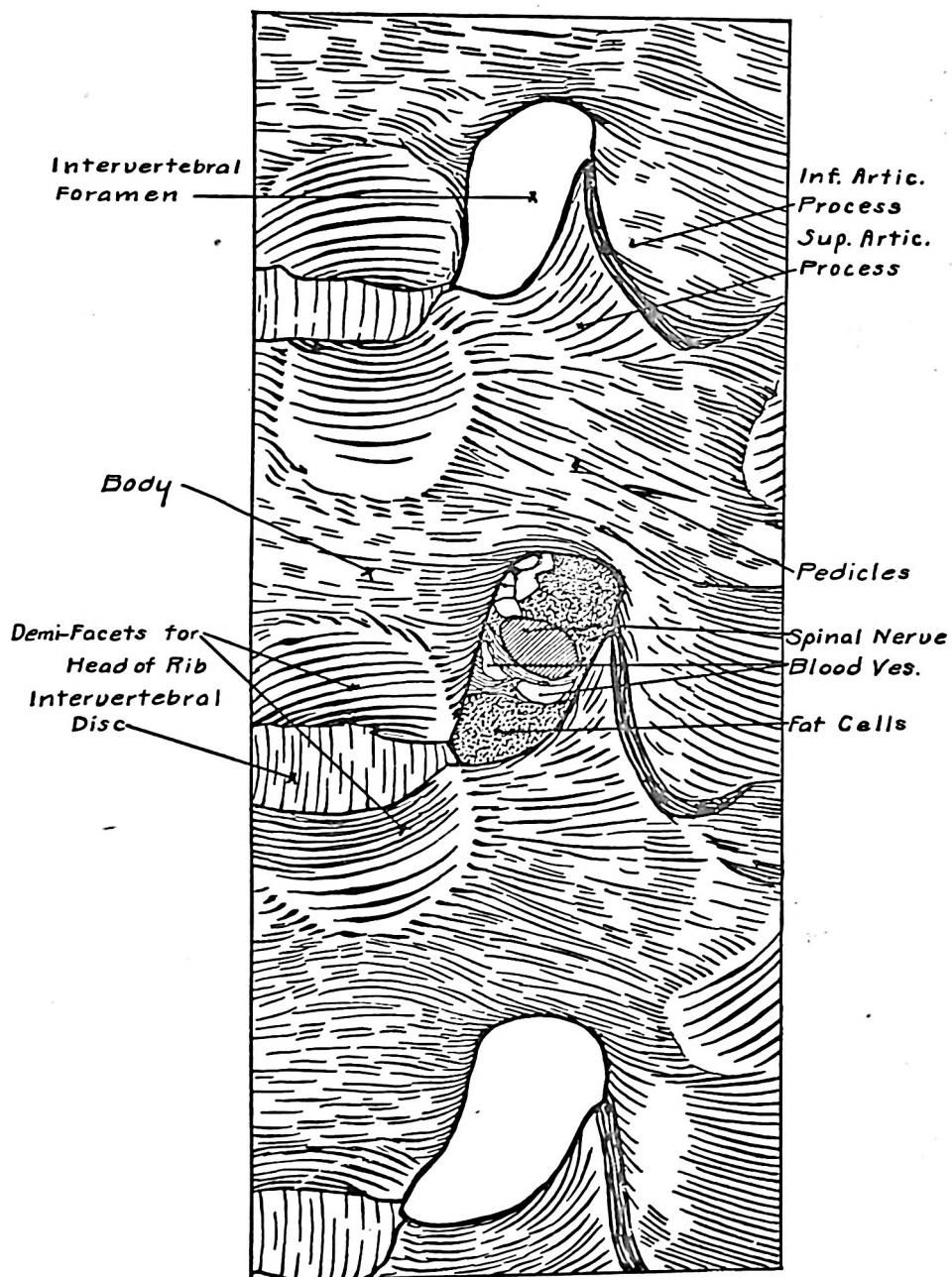


Fig. 26. Intervertebral Foramina Superior to the 4th, 5th, 6th Dorsal Vertebrae—Cross Section of Spinal Nerve Shown in foramen.

The second pair of intervertebral foramina are formed between the inferior surface of the posterior arch of the atlas and the superior surface of the laminae of the axis. They are also posterior to the articular processes. These foramina are formed by grooves in the superior surface of the laminae of the axis and the inferior surface of the posterior arch of the atlas, which are converted into foramina by the attachment of the atlanto-axial ligament.

The Intervertebral Foramina in the balance of the spine are formed between the pedicles of the vertebrae by the intervertebral grooves.

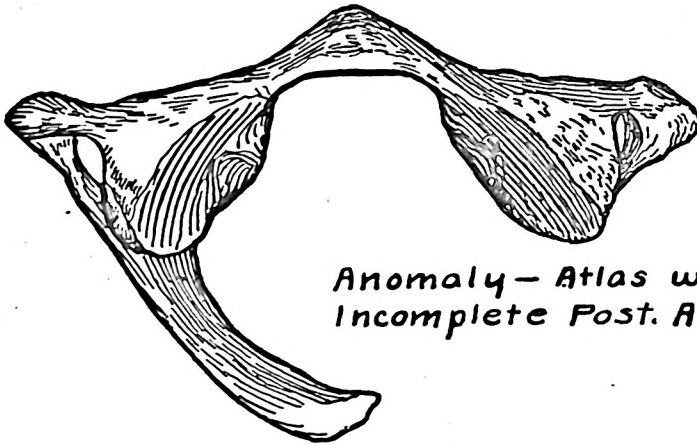
**Boundaries:—**

See illustration No. 26.

The floor of the foramen is formed by the groove in the superior surface of the pedicle of the vertebra below. The roof is formed by the groove in the inferior surface of the pedicle above.

In the cervical region the anterior wall is formed by a portion of the superior edge of the anterior surface of the body of the vertebra below, by a portion of the inferior edge of the anterior surface of the body of the vertebra above and the intervening intervertebral disc. In the dorsal region the anterior wall is formed principally by a portion of the inferior half of the anterior surface of the body of the vertebra above and the intervertebral disc; none of the surface of the body below enters into the formation. In the lumbar region a portion of the two bodies help to form the anterior wall with the intervening intervertebral disc.

The posterior wall of the intervertebral foramen in all three regions of the spine is formed by the superior articular process of the vertebra below and a small portion of the lamina of the vertebra above.



*Anomaly - Atlas with  
Incomplete Post. Arch*

PART III.

The Dorsal Region



Fig. 27. Lateral View of the Dorsal Region.

## The Dorsal Region

Fig. 27.

The division of the spinal column which passes through that part of the body called the thorax is known as the Dorsal, or Thoracic region, dorsal meaning back. The number of segments in this region of the spine corresponds to the number of ribs on either side, which is twelve. Occasionally there may be thirteen or only eleven, but when there is a variation in the number of segments, one more or one less, there will be a like variation in the number of ribs. This region of the spine is about eleven inches in length although this would vary a little with different individuals.

The dorsal region helps to form the thorax therefore is also called the thoracic region; it helps to protect the viscera, gives attachment to the ribs, ligaments and muscles, and supports the weight of the trunk. This region is curved slightly, with the convexity toward the posterior and concavity toward the anterior, forming a primary or posterior curve.

There is sometimes a very slight physiological lateral curvature in the dorsal region with the convexity toward the right side. This slight gradual lateral bending of the spine extends from the fifth dorsal to the second lumbar vertebra. This condition may be due to the muscles of the right side being developed more than those of the left because of the right hand being used more than the left, but this condition may also appear in left handed people so it is thought to be the result of pressure from the upper part of the thoracic

aorta on this region causing a slight bending of the spine toward the right side. It is also claimed by Wood that the left side of the body of the fifth dorsal vertebra is somewhat flattened by pressure from the thoracic aorta, this flattened depression being called the *Impressio Aorta*. If this is true it is reasonable to suppose that sufficient pressure to produce this condition of the body of one of the vertebrae might also push the vertebrae out of the median line and cause a slight curvature. This condition, however, must not be considered as pathological, for a condition taking place in this way would enable Innate intelligence to bring about an intellectual adaptation that would prevent pressure from being produced upon the spinal nerves. It must also be remembered that there might be such an enlargement of the thoracic aorta making the pressure on the spine so great that the slight curvature would be exaggerated to the point where pressure would be produced on the spinal nerves; but even then this curvature is adaptative and in correcting the condition the physical representative of the cause of the primary condition to which the curvature is adaptative must be found and adjusted.

The transverse width of the bodies of the dorsal vertebrae decreases from the body of the first dorsal down to the body of the fifth dorsal and increases from the fifth down to the twelfth. As we proceed toward the middle dorsal region it is found that the intervertebral discs become more typically wedge shaped, thicker at the posterior than at the anterior, in accommodation to the posterior curve in this region.

#### **Differentiating Features.**

The shape and general appearance of the dorsal vertebrae would enable the student to recognize the segments of this

region from those of the other regions of the spine, but there are points which are found on these vertebrae that are not found on the other vertebrae and these are known as the DIFFERENTIATING FEATURES. In examining a dorsal vertebra it will be found that there are articulating surfaces on the bodies which receive the heads of the ribs. These articulating surfaces are known as Facets or Demi-facets according to whether the articulating surface is on one body or divided, with half on one body and half on the adjacent body. Where the rib articulates with the body of one vertebra only, that vertebra will have a whole facet. But some of the ribs articulate with the bodies of two vertebrae, that is one-half of the head will articulate with the inferior edge of one body and the other half with the superior edge of the adjacent body, making a demi- or half facet on each. These demi-facets are known as the Fovea Costalis Superior and the Fovea Costalis Inferior.

Aside from the facets and demi-facets on the bodies of the dorsal vertebrae, the transverse processes have articulating surfaces for the articulation of the condyles of the ribs. These articulating surfaces are found on the transverse processes of all the dorsal vertebrae except those of the eleventh, twelfth and sometimes the tenth.

Another differentiating feature in this region is the shape of the spinous process, which is long and slender, triangular on cross section and points obliquely downward.

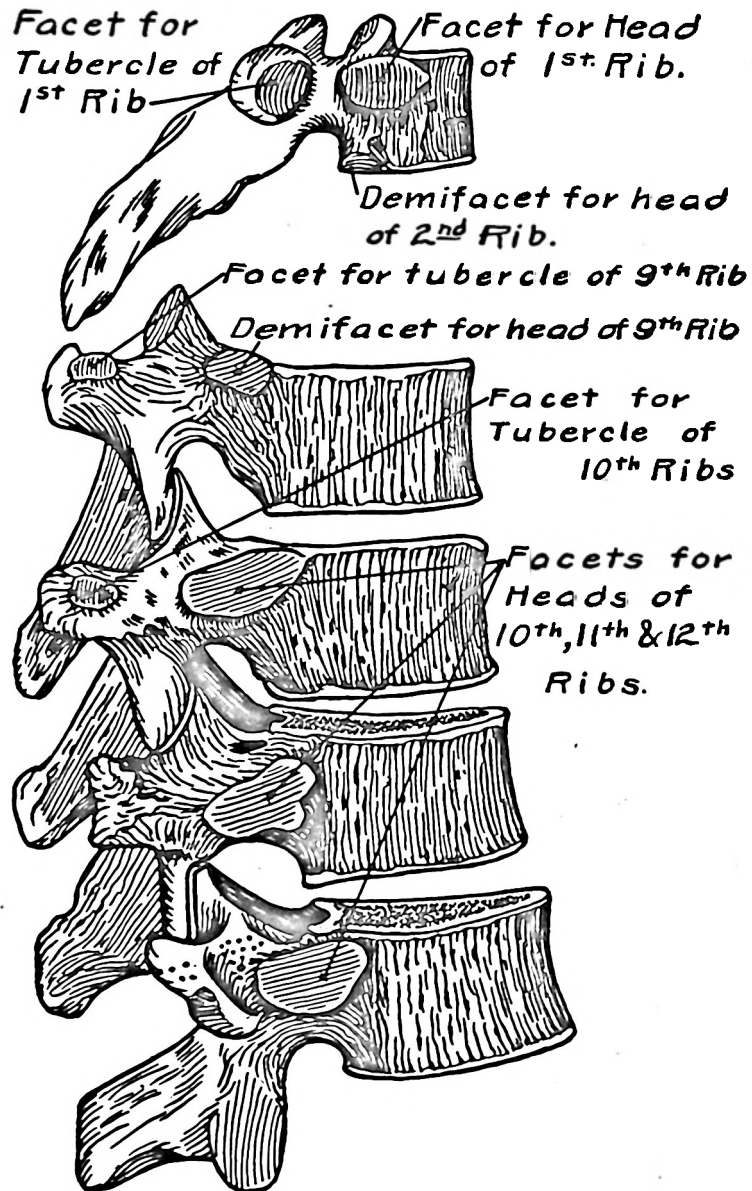


Fig. 28. Peculiar Dorsal Vertebrae

## Peculiar Dorsal Vertebrae

Fig. 28.

The student must not confuse the Differentiating Features with the peculiar vertebrae of a region. It is our object here to merely name the peculiar dorsal vertebrae and then thoroughly describe them in a later chapter.

### The Peculiar Dorsal Vertebrae.

First	Tenth	Twelfth
Ninth	Eleventh	

The peculiarity of these vertebrae consists chiefly in the manner in which the facets and demi-facets are placed on their bodies. This is thoroughly explained in the description of the vertebra in the Comparative Study of the Dorsal Vertebrae.

## The Typical Dorsal Region

The typical Dorsal region consists of the segments from the second to the eighth inclusive. These segments are called the typical dorsal vertebrae because they all have the same points for description and are the same except that there is an increase in size as the extremities of the region are approached. There is also a slight difference in the general appearance and direction of the parts.

A typical dorsal vertebra consists of a body and a neural arch which supports seven processes. The Neural Arch is formed by the pedicles and laminae, and the seven processes are the two Transverse Processes, the four Articular Processes and the Spinous Process. All these segments present two demi-facets on either side for the articulation of the heads of the ribs. In the upper part of the region they are formed on the bodies but in the lower part they are formed on the vertebral roots. There is an articulating surface on the anterior surface of the tips of the transverse processes for articulation with the condyle of the rib. These are called the Fovea Costalis Transversalis.

The descriptive parts of a typical Dorsal vertebra are:

One Body	Two Laminae
Two Pedicles	Four Articular Processes
One Spinous Process	

### The Body

The body of a typical dorsal vertebra is composed of a spongy mass of bone tissue, the outer layer of which consists

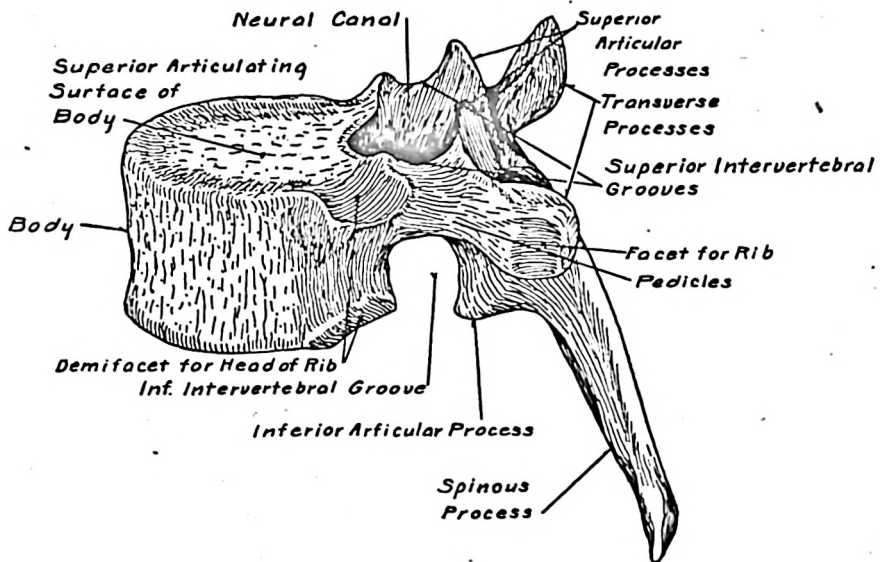


Fig. 29. Typical Dorsal Vertebra (6th Dor.).

of more solid compact bone and is perforated by many small openings called foramina for the passage of nutrient vessels, such as the blood vessels and the lymphatics, to the interior of the body of the vertebra. The superior and inferior surfaces are heart shaped owing to the fact that the posterior surface is concave from side to side and the transverse width is less than the antero-posterior diameter.

#### **Anterior Surface.**

The anterior, or ventral surface of the body of a typical dorsal vertebra is convex transversely (from side to side) and concave vertically (from above downward). This concavity from above downward is produced by a constriction around the center of the body transversely. The Anterior Common Ligament is attached to this surface.

#### **Posterior Surface.**

The posterior surface, or dorsum, of the body forms the neural arch into a ring forming the anterior wall of this ring. All the neural rings together form the neural canal. This posterior surface is straight vertically, or from above downward and is concave transversely, or from side to side. In this surface near the center will be found a large foramen for the passage of nutrient vessels. The pedicles arise from the superior portion of the dorsum of the body at either side.

#### **Lateral Surfaces.**

There is not much to be said of the lateral surfaces of the body of a dorsal vertebra. The constriction around the center of the anterior surface extends around the lateral surfaces and it is on these surfaces that the demi-facets or fovea costallis superior and inferior are found in the upper portion of the typical dorsal region. There are four of these demi-

facets, two on either side, one superior and one inferior. The two superior ones are formed on the superior margin, just anterior to the point where the pedicles arise. The inferior demi-facets are formed on the posterior inferior margin of the lateral surfaces.

#### **Superior and Inferior Surfaces.**

The superior and inferior surfaces of the body of a typical dorsal vertebra are deeply concave to receive the convexity of the intervertebral discs. Around the outer edge there is a layer or ring of solid compact bone known as the Epiphyseal Plate, which deepens the concavity. In early life, before these plates have ossified and become a part of the superior and inferior surfaces of the body, we find that the bodies are not concave but there is only a slight depression in the center and that the edges to which the epiphyseal cartilage is firmly attached are corrugated.

#### **Epiphyseal Plates.**

In early life there is a layer of Hyalin cartilage between the intervertebral disc and the body of the vertebra. This cartilage has a center of ossification. About the age of puberty the process of ossification begins and this cartilage is formed into a plate or layer of very solid compact bone tissue known as the Epiphyseal Plate. The white fibers of this intervertebral disc are interwoven with the fibers of the hyalin cartilage and when this cartilage ossifies these white fibers are held very firmly in this epiphyseal plate and thus forms a very firm union between it and the intervertebral disc. The epiphyseal plate, by this process of ossification, becomes attached to the body of the vertebra and really becomes a part of it for it becomes impossible to separate the two. Thus we can see what

a firm attachment there is between the intervertebral disc, the most powerful ligament in the body, and the body of the vertebra. The process of ossification in the epiphyseal plate is completed about the twenty-first to the twenty-fifth year.

### The Pedicles

The pedicles, which are also called the roots of the vertebral arches, are two short, supposed to be foot-like, processes of solid compact bone tissue. They project backward from the superior portion of either side of the posterior surface of the body and as they proceed toward the posterior they slightly diverge. There is a slight groove or notch in the superior surfaces called the intervertebral grooves. When the vertebrae are articulated together, one on top of the other, these notches form the floor of the intervertebral foramina next above. The intervertebral grooves in the inferior surfaces are very much deeper than those in the superior surfaces; they form the roof of the intervertebral foramen next below when the vertebrae are in situ. The inferior intervertebral groove is made deeper by reason of the pedicle being attached to the upper border of the posterior surface of the body of the vertebra.

The intervertebral grooves are found in the superior and inferior surfaces of the pedicles of all the true vertebrae except the superior surface of the pedicles of the axis, which are covered by the superior articular processes and the atlas which has no pedicles. The pedicles form the lateral portion of the neural arch.

### The Laminae

Joined firmly to the pedicles and projecting backward from them, are the laminae which are composed of solid, com-

pact bone tissue and, as the name indicates, are flat, plate-like processes, the word lamina meaning layer or plate. As the laminae proceed backward they converge until they meet in the posterior median line where they fuse together and complete the neural arch and form the spinous process.

When the vertebrae are articulated together in a superimposed manner the laminae are imbricated, that is, they overlap in such a way as to complete the vertebral canal at the posterior, leaving no opening or space between the vertebrae at the posterior.

### Transverse Processes

At either side of the neural arch, and arising at the junction of the pedicles with the laminae are two processes of solid compact bone tissue called the Transverse, or Muscular Processes. These processes are comparatively heavy and while they project laterally and for that reason are called the transverse processes, yet they also point toward the posterior and slightly toward the superior. This varies, however, in the different segments and this variation will be carefully considered in the section on the Comparative Study of the Dorsal Vertebrae.

On the anterior surface of the transverse processes there is an articulating facet which receives the articulating tubercle on the condyle of the rib. The head of the rib articulates with the bodies of the vertebrae at the junction of the pedicles with the body while the condyle of the rib articulates with the transverse process. This leaves an opening or space between the posterior surface of the neck of the rib and the anterior surface of the transverse process which is analogous to the Foramen Transversarium, or foramen in the transverse processes in the cervical region.

In some cases, if the patient's back is not too muscular, the transverse processes may be palpated, but they do not afford a reliable source for information regarding vertebral subluxations. They may be used as levers upon which to adjust in certain combinations of directions but the transverse process is never used as a point of contact when it is at all possible to use the spinous process.

The transverse processes are largest and longest in the upper dorsal region and decrease in length until they are entirely absent on the eleventh and the twelfth.

### Articular Processes

#### Superior Articular Processes.

There are four articular processes which support the four articulating surfaces. The Superior Articular Processes, or Pre-zygapophyses, are formed at the junction of the pedicles with the laminae and project upward almost perpendicular; the plane of the articulating surface is at an angle of about  $68^{\circ}$ . This surface is located on the posterior surface of the articular process, is flat, and oblong in shape and is directed toward the posterior and slightly upward. These articular processes stand out distinct and separate from the parts from which they arise.

#### Inferior Articular Processes.

The Inferior Articular processes, or Post-zygapophyses, arise at the junction of the pedicles with the laminae and project downward; they are joined to, and really become a part of, the anterior-inferior surface of the laminae. The articulating surfaces are located on the anterior surfaces of the inferior articular processes, the plane of which is almost per-

pendicular, being at an angle of about  $68^{\circ}$ , which is the same as that of the superior articulating surfaces with which they articulate. This angle varies from the superior to the inferior dorsal region and this variation will be carefully noted in the section on Comparative Study of the Dorsal Vertebrae. The surfaces look toward the anterior and slightly downward, just opposite to those of the superior processes.

### Spinous Processes

The spinous processes of the vertebrae are by far the most important processes to the Chiropractor, for it is by palpating the spinous processes that he is able to locate the physical representative of the cause of disease. Therefore a special study should be made of the spinous processes, and in the section devoted to this subject it is the aim to present each spinous process in its relation to the other parts of the vertebrae, thus familiarizing the student with the peculiarities and distinctive characteristics of each.

The spinous process of a typical dorsal vertebra is composed of solid compact bone tissue; it is located in the posterior median line and is formed by the junction of the laminae. In this region they are very long, slender and triangular on cross-section, and they terminate in a small tubercle at the apex. One thing that must be taken into consideration is the direction in which these processes point; instead of pointing toward the posterior they are directed obliquely downward at an angle of about  $60^{\circ}$ , and the processes being so long this makes the tip of the spinous process quite a little below the rest of the vertebrae. This fact must be taken into consideration when palpating in the dorsal region.

## A Comparative Study of the Dorsal Vertebrae

### First Dorsal Vertebra

The first dorsal vertebra is given as a peculiar dorsal vertebra because it has a whole facet and a demi-facet on either side of the body. The first pair of ribs articulate with the body of the first dorsal vertebra by means of a whole facet on either side. The second pair of ribs articulate, not only with the body of the second dorsal vertebra, but they are set a little high so that they articulate with the inferior edge of the body of the first. This is what makes the two demi-facets or fovea costalis inferior on the body of the second.

The transverse width of the body of the first dorsal is a little greater than that of those immediately above or below since the body of this vertebra forms the base of the first and the second pyramidal divisions of the spine.

The spinous process is comparatively heavy for the dorsal region and does not point so much toward the inferior as those immediately below. It points downward at an angle of about  $40^{\circ}$ . The plane of the articulating surfaces is about  $60^{\circ}$  from a horizontal plane.

The transverse processes of the first dorsal vertebra are somewhat larger than those in the balance of the dorsal region and are not directed toward the posterior. This vertebra is sometimes more prominent than the seventh cervical and in such cases is listed as Vertebra Prominens.

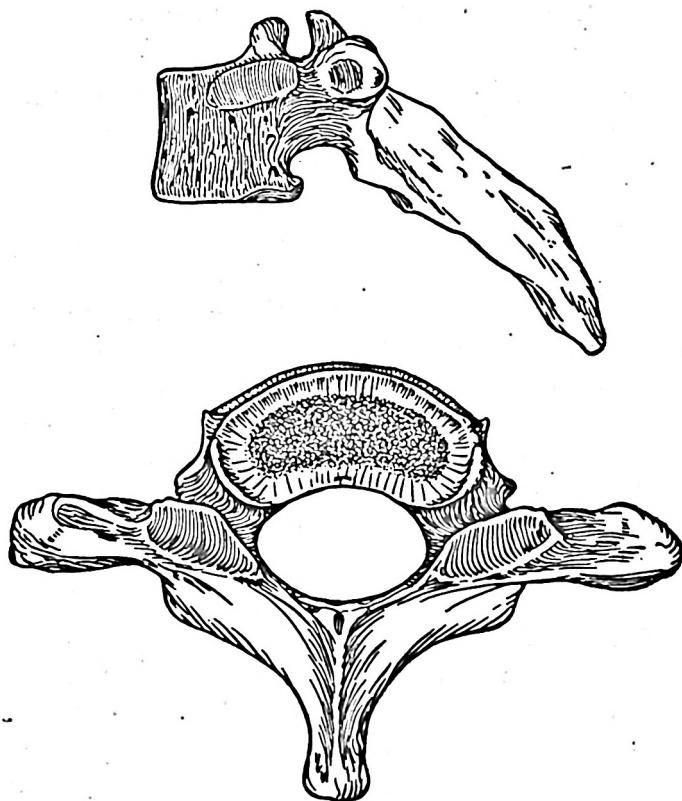


Fig. 30. First Dorsal Vertebra.

## Second Dorsal Vertebra

The second dorsal vertebra belongs to the typical dorsal region because it has two demi-facets on either side. The body of this vertebra would be described in the same manner as that of any of the other typical dorsal vertebrae. The transverse width is just a little less than that of the first. The transverse processes are larger than those of the first dorsal but are slightly shorter. On the specimen used for the illustration the measurement from the tip of one transverse process to the tip of the other is less by a quarter of an inch. The transverse processes of this vertebra are directed backward at an angle of  $19^{\circ}$  to a transverse plane. They have on the anterior surface the articulating surfaces for the articulation of the condyles of the second pair of ribs. The heads of the second pair of ribs articulate with the body of the second dorsal vertebra by means of the superior pair of demi-facets and the third pair of ribs articulate with the second dorsal vertebra by means of the inferior pair of demi-facets. The superior demi-facets are found on the body of the second dorsal just anterior to the attachment of the vertebral arches to the body. The inferior demi-facets are formed on the inferior margin at the extreme anterior.

The pedicles, the laminae, and the articular processes of the second dorsal are about the same as those of the other typical dorsal vertebrae. The articulating surfaces are at an angle of about  $60^{\circ}$ , while farther down they are more nearly perpendicular. The spinous process, however, is a little dif-

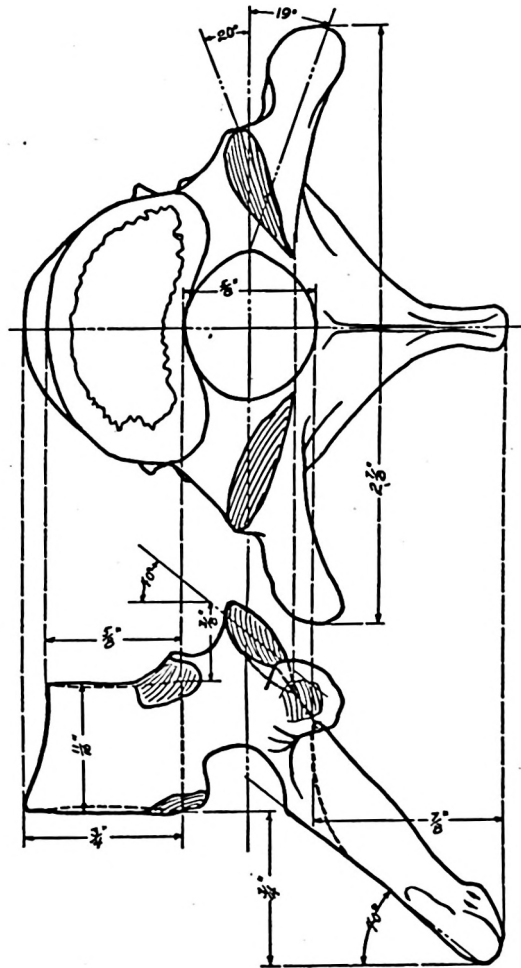


Fig. 31. Second Dorsal Vertebra (Mechanical Drawing).

ferent; it is a little heavier than those in the middle dorsal region, but is usually not quite so long. It points downward at an angle of about  $40^{\circ}$  to a transverse plane. This is a little greater angle than that of the first but not quite so great as that of the third.

The neural ring of the second dorsal of the specimen used is a little larger than that of the first, as may be seen in the drawing. The ellipse more nearly approaches the circle. There is less difference between the two dimensions, antero-posterior and transverse, of the ellipse in the second than in the first. It will be noticed that the antero-posterior width of the neural ring is exactly equal to the antero-posterior dimension of the superior surface of the body.

### Explanation of Mechanical Drawing

The cut, Fig. 31, is a mechanical drawing of the second dorsal vertebra showing the side elevation and the plan. This drawing is life size and an exact reproduction of the specimen that was used for the illustration. The measurements are exact. It will be observed that all projections are clearly shown.

It is the desire of the author to show the exact difference between the segments of the spine and this can best be done by showing the pictures of each separate segment. Therefore we have prepared a drawing of each segment of the spine. Our first thought was to make a mechanical drawing of each segment, but as there are many who do not understand the reading of a mechanical drawing, it has been thought best to show simply the drawing of each segment as an example for measurements and put in no dimensions. This one mechanical drawing is placed here that the student, who so desires, may

understand how to measure the other drawings and get the angles as they are in the specimen.

The student is urged to measure these drawings to understand the differences in the angles of the different processes, such as the spinous processes, the transverse processes, articular processes, and as these drawings are absolutely true to the specimen, these measurements may be worked out exactly.

While the measurements of the vertebrae differ with different spines, the comparison would be the same. The spine from which these drawings were made is an average specimen so the student may obtain a good idea of the general run of the segments.

The student's attention is called to the different measurements. It will be noted that the spinous process points downward at an angle of  $40^{\circ}$ . If the protractor is placed on the spinous processes of the drawings of the other vertebrae in the manner indicated by the line on this one the student will get the exact angle of each one. It is suggested that this be done. The transverse processes of this vertebra point toward the posterior at an angle of  $19^{\circ}$ . If the transverse processes of the other drawings are measured it will be found that this angle changes as we proceed down the spine. A change in the angle of the articulating surfaces will also be observed.

Notwithstanding the fact that the spinous processes in the dorsal region are by far the longest in the spine, it will be observed by measuring the horizontal distance from the tip of the spinous process to the plane of the posterior surface of the body of the vertebra of a straight superior view, that there is no great difference in the distance of the tip of the spinous process from the posterior surface of the body in the different segments of the spine; this dimension is almost con-

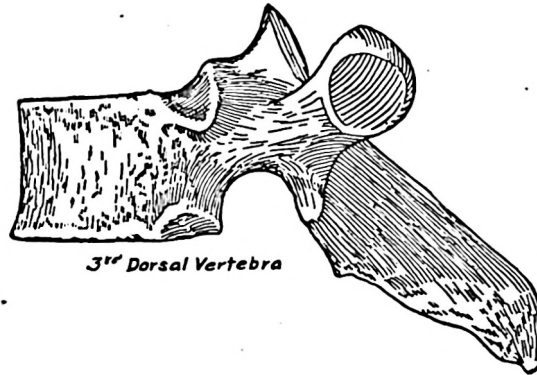
stant throughout the spine because the spinous processes point downward at a different angle in the different parts of the spine. This dimension in the second dorsal vertebra is one and one-half inches. With the fourth cervical it is one and one-quarter inches, while that of the fifth lumbar is one and one-half inches.'

### Third Dorsal Vertebra

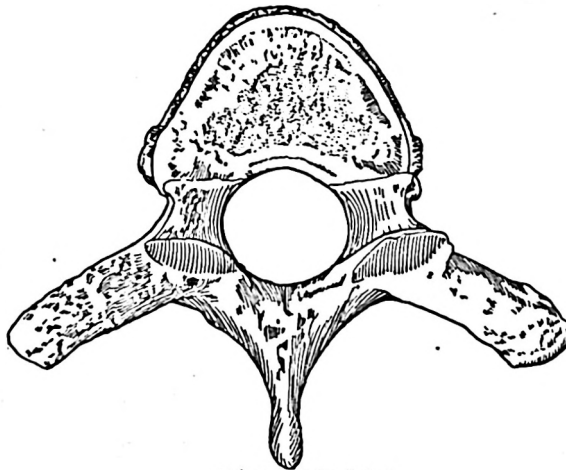
It would be quite difficult to distinguish between a third dorsal vertebra and a second or fourth, although there is some difference; but as this difference is comparative it would be almost necessary to have the segments together in order to make the comparisons.

The transverse width of the body of the third is a little less than that of the second; the four demi facets are located on the body; the two superior demi facets, or fovea costalis superior, for the heads of the third pair of ribs are formed at the superior border just in front of the junction of the pedicles with the body; the two inferior ones, or fovea costalis inferior, are formed on the anterior portion of the inferior border. The transverse width of the body of this vertebra is less than that of the second, therefore the transverse width of the neural ring is correspondingly less, for the posterior surface of the body forms the anterior wall of the neural ring.

Upon close observation it will be found that the transverse processes are a little shorter than those of the second dorsal, although this difference is very slight. They are directed toward the posterior at an angle of about  $25^{\circ}$  to  $28^{\circ}$ . The spinous process is just a little thinner and points downward a little more, possibly two or three degrees more, making an angle of about  $43^{\circ}$ .



*3rd Dorsal Vertebra*



*3rd Dorsal Vertebra*

Figs. 32, 33.

The other descriptive parts are just about the same as those of the second dorsal; the difference is not sufficient to enable the student to differentiate between the two segments by considering them.

### Fourth Dorsal Vertebra

In comparing the fourth dorsal vertebra with the first dorsal vertebra we find quite a marked difference, especially in the bodies, the transverse processes, the spinous process and the angle of the plane of the articulating surfaces. However, there is not a great deal of difference between the fourth and the fifth or the fourth and the third.

The transverse width of the body of the fourth is a little less than that of the third and therefore the neural ring is a little smaller. The pedicles are a very little shorter.

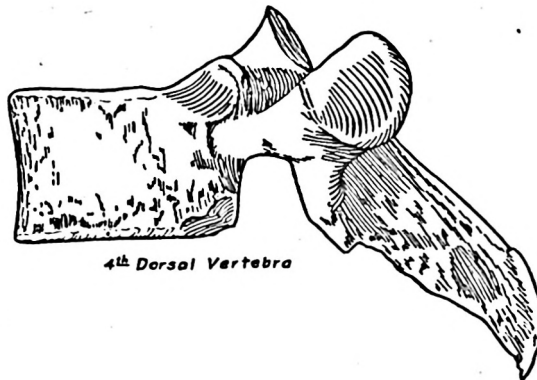
The spinous process is thinner and more pointed and extends downward at a greater angle, usually about  $46^{\circ}$ . The transverse processes point backward at an angle of from  $28^{\circ}$  to  $30^{\circ}$ .

The fovea costalis superior, or superior demi-facets, on the body of this vertebra are so formed as to extend on to the pedicle just where it is attached to the body of the vertebra.

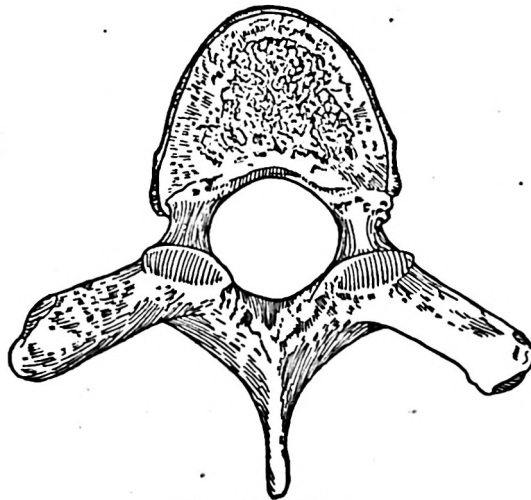
The articulating surfaces are placed at an angle of about  $75^{\circ}$  to a horizontal plane.

### Fifth Dorsal Vertebra

The fifth dorsal is the center of the spine, it being the twelfth segment from above and the thirteenth from below. The body of this vertebra is the smallest of any in the dorsal region. It forms the apex of the second and third pyramidal



4<sup>th</sup> Dorsal Vertebra



4<sup>th</sup> Dorsal Vertebra

Figs. 34, 35.

divisions of the spine. The transverse width is less than that of the fourth dorsal. Because of the size of the body and because the pedicles are a little shorter than those of the other dorsal vertebrae, the neural ring of the fifth dorsal is smaller than that of any of the others. The left side of the body is somewhat flattened by reason of the pressure from the thoracic aorta.

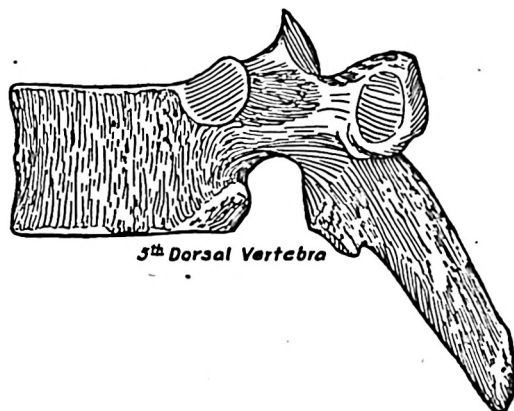
At this point in the spine it will be found that the fovea costalis superior are formed further toward the posterior so that they extend on to the pedicles as much or more than they do on the side of the body.

The transverse processes are not quite as long as those of the fourth dorsal. They are directed toward the posterior at an angle of about  $30^{\circ}$ . The spinous process is set at a greater angle, being about  $60^{\circ}$  or a little more in some cases. The spinous process of the fifth dorsal is the thinnest and the most frail of any of the spinous processes in the dorsal region.

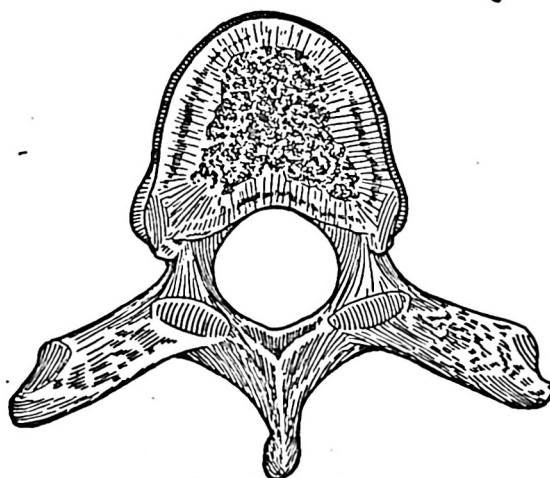
### Sixth Dorsal Vertebra

There is a gradual increase in the transverse width of the bodies of the dorsal vertebrae usually beginning at the sixth; the transverse width of the sixth is slightly greater than that of the fifth.

There is very little difference between the sixth and the fifth dorsal vertebrae. The fovea costalis superior are located more on the pedicles. The spinous process is about the same as that of the fifth, pointing downward at an angle of about  $65^{\circ}$  to  $68^{\circ}$  to a horizontal plane. The transverse processes are a little shorter than those of the fifth, and are directed backward at an angle of  $30^{\circ}$  to  $32^{\circ}$ .



*5th Dorsal Vertebra*



*5th Dorsal Vertebra*

Figs. 36, 37.

### Seventh Dorsal Vertebra

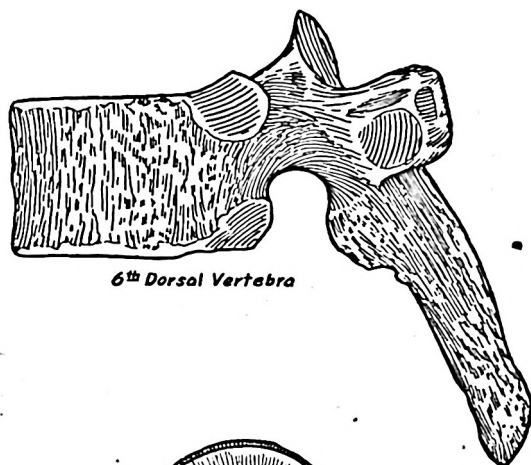
The transverse width of the body of the seventh dorsal vertebra is a little greater than that of the sixth. There is not a great deal of difference in the spinous processes of the sixth and seventh. The seventh points downward at an angle of  $65^{\circ}$  to  $75^{\circ}$  to a horizontal plane. The transverse processes are directed backward at an angle of about  $32^{\circ}$ .

The fovea costalis superior, or the demi facets, for the articulation of the heads of the seventh pair of ribs are formed on the lateral aspect of the pedicles instead of on the sides of the body of the vertebra.

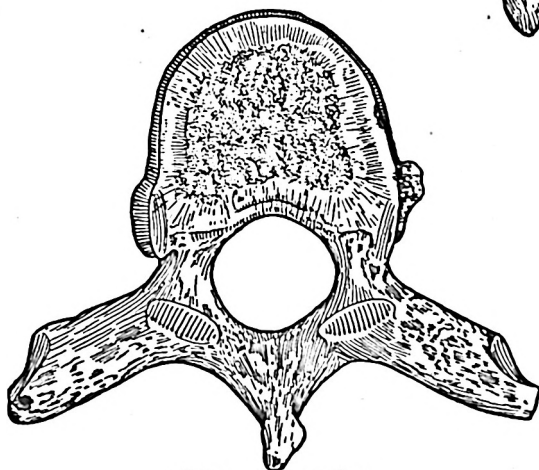
### Eighth Dorsal Vertebra

The eighth dorsal vertebra is the last or most inferior typical dorsal for it is the last one to present four demi facets. The two superior demi facets, or fovea costalis superior are formed on the lateral aspects of the roots of the vertebral arch, or pedicles; the inferior demi facets, fovea costalis inferior, are formed on the lateral inferior surfaces the same as the other typical dorsal vertebrae.

The transverse width of the body of the eighth is greater than that of the seventh. The fact is the vertebra is a little larger in every way than those from the fifth to the eighth. The spinous process is a little heavier than that of the seventh; the angle is less. In the majority of cases this spinous process is directed downward at an angle of from  $60^{\circ}$  to  $65^{\circ}$  to a horizontal plane. The transverse processes are about the same as those of the seventh in size and shape. They point toward the posterior at an angle of about  $32^{\circ}$ .

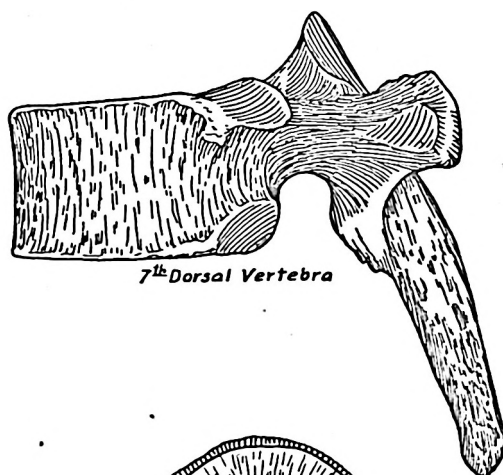


6<sup>th</sup> Dorsal Vertebra

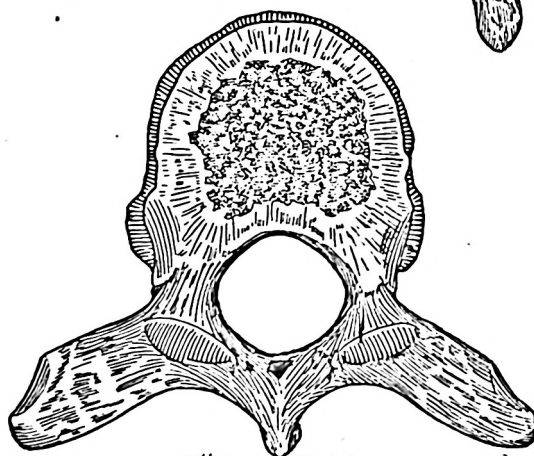


6<sup>th</sup> Dorsal Vertebra

Figs. 38, 39.

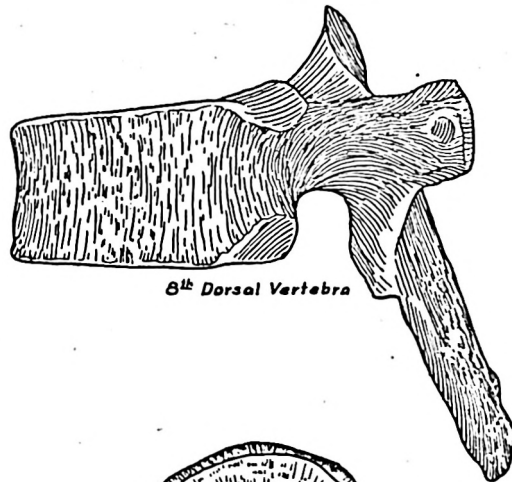


*7<sup>th</sup> Dorsal Vertebra*

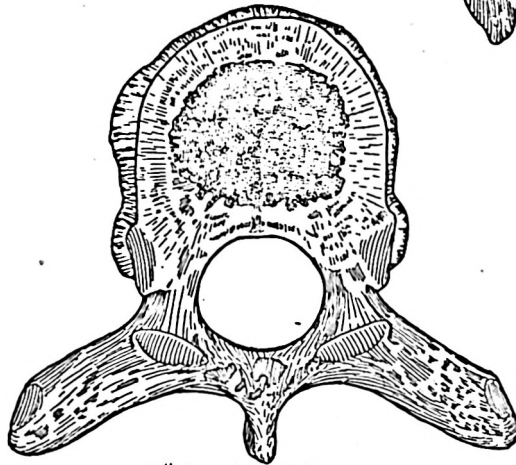


*7<sup>th</sup> Dorsal Vertebra*

Figs. 40, 41.



8<sup>th</sup> Dorsal Vertebra



8<sup>th</sup> Dorsal Vertebra

Figs. 42, 43.

### Ninth Dorsal Vertebra

The ninth dorsal vertebra is peculiar because there is only one demi-facet on either side. This is because the tenth pair of ribs do not articulate with the body of the ninth dorsal vertebra but only with the body of the tenth. This leaves the ninth with only the demi-facets or the fovea costalis superior, for the heads of the ninth pair of ribs. In some specimens, however, this varies and in some instances the ninth may be a typical dorsal because this would leave the tenth with only one fovea costalis superior. In some cases there may be only one demi-facet on one side and two on the other. The fovea costalis superior of the ninth dorsal are formed on the lateral sides of the pedicles instead of on the body of the vertebra.

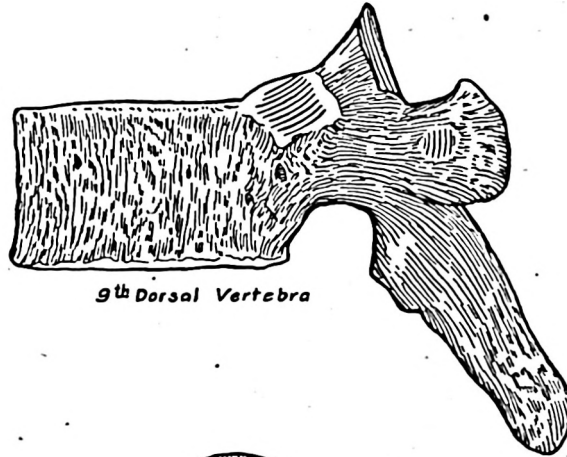
In addition to this peculiarity we find that the segments of the lower dorsal region take on more of the general appearance of the lumbar vertebrae. The transverse diameter of the body of the ninth is greater than that of the eighth; it is also slightly heavier.

While the transverse processes are a little shorter than those of the eighth, they point toward the posterior at an angle of about  $35^{\circ}$ , which is a little more than those of the eighth. The fovea costalis transversalis are about the same on the transverse processes of the ninth as on those of the eighth.

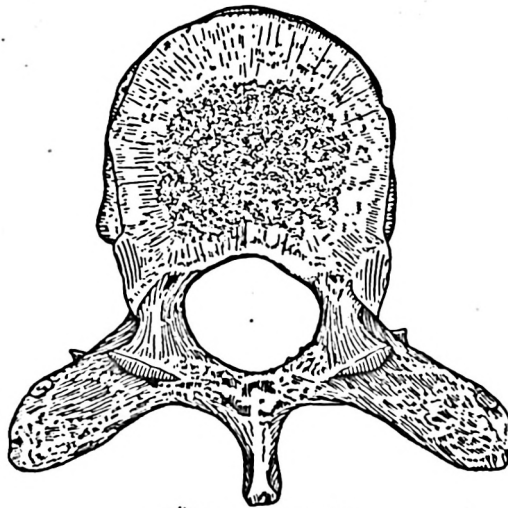
The spinous process of the ninth dorsal vertebra is not quite as long as that of the eighth, but it is a little heavier and points downward at an angle of about  $40^{\circ}$  to  $45^{\circ}$ .

### Tenth Dorsal Vertebra

The tenth dorsal vertebra is a peculiar dorsal vertebra because there is a whole facet on either side but no demi-facets. These facets are formed on the sides of the pedicles instead



*9<sup>th</sup> Dorsal Vertebra*



*9<sup>th</sup> Dorsal Vertebra*

Figs. 44, 45.

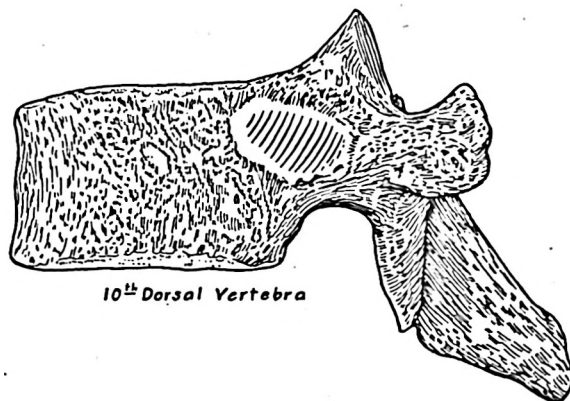
of on the body. Beginning with this vertebra we find quite a marked change in the general shape of the vertebrae. The segments here take on more of the characteristics of the lumbar vertebrae. While the tenth is by no means a transitional vertebra, yet there is sufficient change from the typical dorsal vertebrae to warrant noting.

The transverse width of the body is slightly greater and slightly thicker than that of the body of the ninth dorsal.

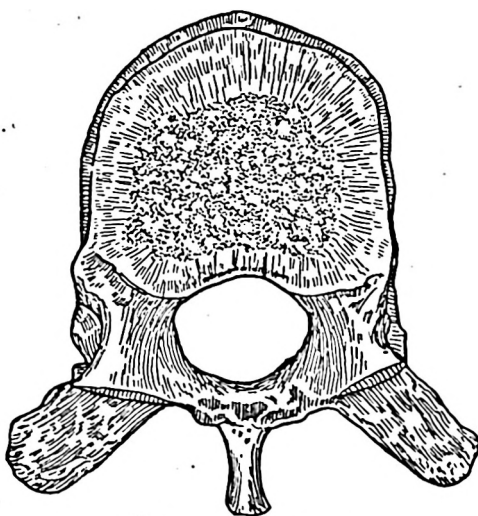
The transverse processes are shorter than those of the ninth. It will be noted that in the upper dorsal region the transverse processes do not point so much toward the posterior, those of the first being almost but not quite at right angles with the antero-posterior plane, but this changes gradually until the tenth is reached, and here we find the transverse processes point toward the posterior at an angle of about 45°. The fovea costalis transversalis, for the articulation of the condyles of the tenth pair of ribs, are located on the anterior surface of the transverse processes.

The spinous process of the tenth is thicker and heavier than that of the ninth. Its extremity is more irregular and points more toward the posterior, forming an angle of about 40°.

It must be remembered that this spinous process is no more prominent than those above, notwithstanding it points toward the posterior and those in the middle dorsal region point downward at an angle of over 65° or more. This is due to the fact that this spinous process is shorter than those above. It will be found that the tip of the spinous process here is almost exactly the same distance from the posterior margin of the neural canal as in the balance of the spine. As a matter of fact there is practically no difference in the distance from the posterior surface of the body to the tip of the



10<sup>th</sup> Dorsal Vertebra



10<sup>th</sup> Dorsal Vertebra

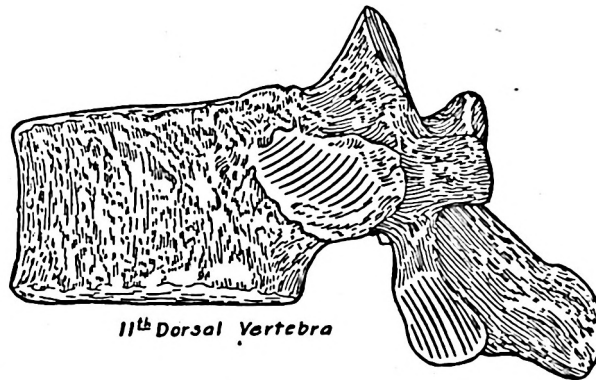
Figs. 46, 47.

spinous process. The tips of the spinous processes are all about the same distance from the perpendicular plane formed by the posterior surface of the bodies of the vertebrae. On the specimen used for these measurements this distance is just an inch and a half, with a variation of only five-sixteenths of an inch. The horizontal distance from the perpendicular plane of the body of the third cervical to the tip of the spinous process of the third cervical is, in this specimen, one inch and three-sixteenths. This distance gradually increases down to the first dorsal where it is one inch and one-half. From here it decreases very slightly down to the eighth dorsal, where it is one inch and five-sixteenths, but this change is so small and takes place so gradually that it is not perceptible from palpation, since the difference is only three-sixteenths of an inch covering a distance of eight vertebrae. From the eighth dorsal down to the fifth lumbar this distance increases from one and five-sixteenths inches to one and eleven-sixteenths inches; this is a difference of three-eighths of an inch distributed between nine vertebrae. The difference in this distance on the third cervical and that on the fifth lumbar is only one-half inch from the third cervical to the fifth lumbar.

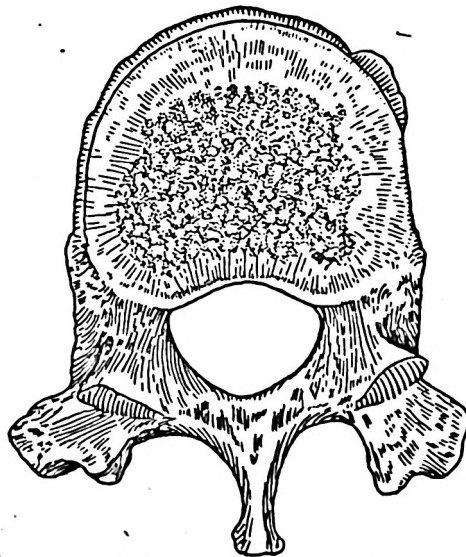
### Eleventh Dorsal Vertebra

The transverse width of the body of the eleventh dorsal vertebra is greater than that of the tenth. There is a whole facet on either side of the vertebra for the articulation of the condyles of the eleventh pair of ribs. These facets are located on the lateral aspect of the roots of the vertebral arches.

The transverse processes of the eleventh dorsal are very short and in some cases are mere tubercles. There are no articulating surfaces on the transverse processes of this vertebra, therefore, there is no articulation between the eleventh



*11<sup>th</sup> Dorsal Vertebra*



*11<sup>th</sup> Dorsal Vertebra*

Figs. 48, 49.

pair of ribs and the transverse processes of the eleventh dorsal vertebra. In cases where the transverse processes are present they are directed backward at an angle of about  $35^{\circ}$ .

The spinous process is thicker and shorter than those of the dorsal vertebra above, therefore its extremity is more clubbed or more blunt. It points downward at an angle of about  $25^{\circ}$ . The articular processes are a little more nearly perpendicular than those of the vertebrae above.

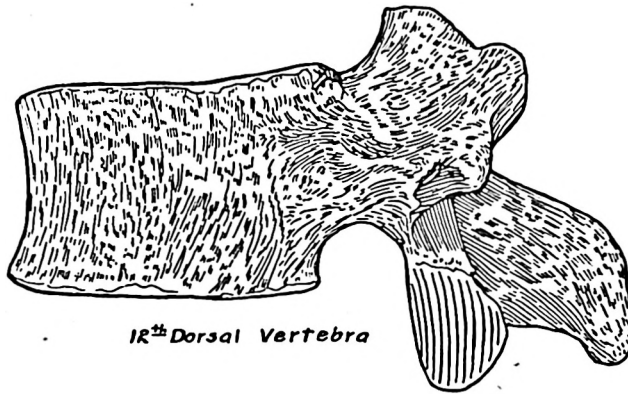
There is very often found on this vertebra a process on either side known as the accessory process. These processes arise at the root of the transverse processes and are directed at a slight degree toward the inferior. They serve to increase the area for the attachment of ligaments and muscles. These accessory processes are not always present in man, but in the lower animals they are present and are well developed.

### Twelfth Dorsal Vertebra

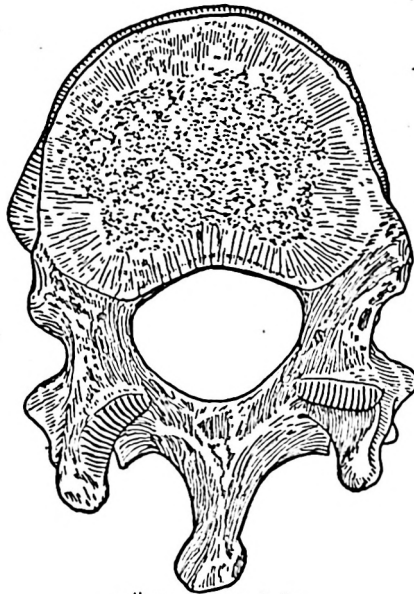
The twelfth dorsal vertebra is a transitional vertebra, that is, being located between the dorsal and lumbar regions, it takes on the characteristics of both the dorsal and lumbar vertebrae. Superiorly it resembles the dorsal region, but inferiorly it resembles the lumbar region.

The transverse width of the body is greater than that of the eleventh dorsal. There is a whole facet on the lateral aspects of either pedicle for the articulation of the head of the twelfth pair of ribs. There are no articulating surfaces on the transverse processes, therefore the twelfth pair of ribs do not articulate with the transverse processes of the twelfth dorsal vertebra.

The transverse processes are mere tubercles, at the root of which are small processes known as the accessory processes.



*12<sup>th</sup> Dorsal Vertebra*



*12<sup>th</sup> Dorsal Vertebra*

Figs. 50, 51.

These project obliquely downward and slightly toward the posterior.

The greatest peculiarity of the twelfth dorsal vertebra consists in the inferior articular processes, which are typical of the lumbar region. In addition to the articulating surfaces which look toward the anterior and slightly toward the inferior, there is an articulating surface formed on the side of the lamina, which in this region, is flattened. This surface looks laterally and articulates with the articulating surface of the mammillary processes on the first lumbar vertebra. The superior articular processes are typical of the dorsal region.

The spinous process of the twelfth dorsal vertebra is broader, heavier and shorter than those above. The downward angle is not so marked, being about  $20^{\circ}$ . It resembles the spinous processes of the lumbar vertebrae.

PART IV.

The Lumbar Region

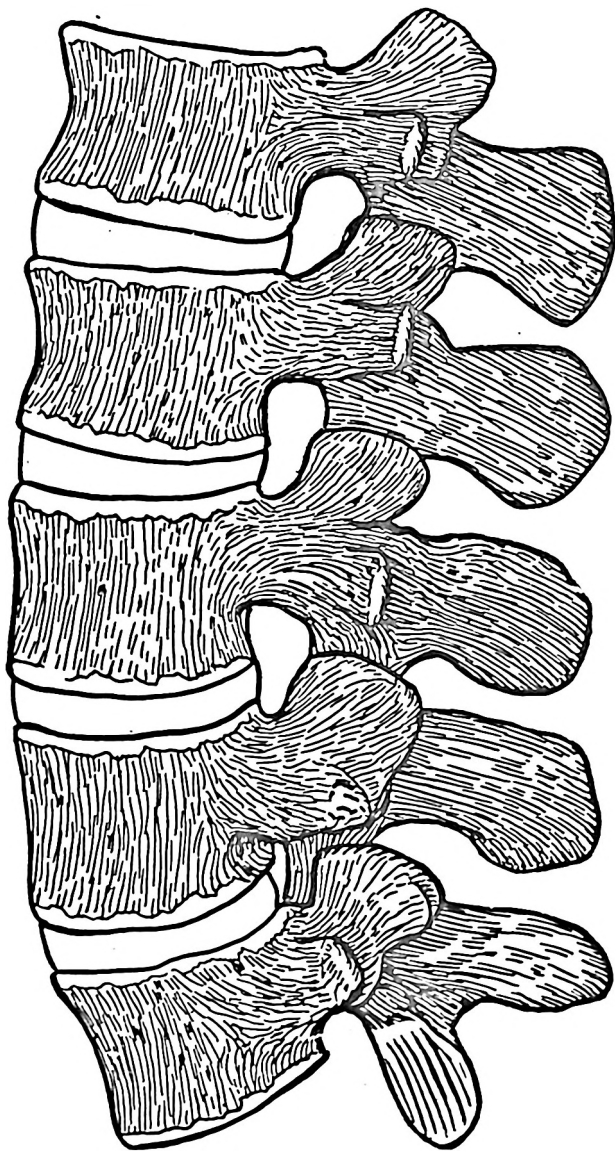


Fig. 52. Lateral View of Lumbar Region.

## The Lumbar Region

The Lumbar region of the spine receives its name from that part of the trunk through which it passes, the loins or lumbo region. The word lumbar is taken from the word "lumbo" which means loin.

There are five segments in this region. They are the largest segments in the spine because they support almost the entire weight of the trunk. The number of segments may vary from four to six, but this is rather unusual, but when it does occur there is likely to be a variation in the number of segments in the cervical region, or in the Sacrum. If there are only four lumbar vertebrae then there will likely be found six segments in the sacrum instead of five. This region is about seven inches in length.

The lumbar region is bent slightly toward the anterior, forming an anterior or secondary curve. The convexity of this curve is toward the anterior and the concavity toward the posterior. This is an adaptative curve which allows for the equalization of the weight of the body. The spinal column being in the posterior median line of the body all the weight of the body is therefore anterior to the column and this must be compensated for in some way so this anterior curve is the compensation.

### Differentiating Features.

The most prominent differentiating feature in the lumbar region is the interlocking articulations formed by the mammil-

lary processes, but the general appearance of the lumbar vertebrae are quite different from that of the cervical and dorsal vertebrae.

### **Mammillary Processes.**

The mammillary processes are nipple shaped processes of bone which arise at the root of the transverse processes and proceed toward the superior where they unite with the superior articular processes and become a part of them.

There is an articulating surface formed on the inner surface of this mammillary process which looks inward toward the median line and articulates with a facet formed on the lateral aspect of the lamina of the vertebra above. This forms the articulation into an interlocking articulation which tends to strengthen this region of the spine, but does not interfere with the movements to any great extent. In the dorsal region there are the ribs which strengthen the spine and help to hold the vertebrae in proper alignment. In the cervical region the lips on the bodies of the vertebrae perform the same function, but in the lumbar region this function is performed by the mammillary processes.

### **Spinous Processes.**

The spinous processes of the lumbar vertebrae differ from those of the other regions of the spine. They are comparatively short, but very heavy and they present a rough, irregular extremity which points almost straight toward the posterior.

The bodies of these segments are kidney shaped and they increase in size from the first to the fifth.

### **The Peculiar Lumbar Vertebra**

The fifth lumbar is given as the peculiar lumbar vertebra. It is peculiar because the circumference of the body is greater than any of the segments in this region. This segment being located in the deep concavity of the back makes the body typically wedge shaped, thicker at the anterior than at the posterior. The body, however, is thinner than the other lumbar vertebrae. The inferior articular processes are set farther apart than those of the other lumbar vertebrae.

### **The Typical Lumbar Vertebrae**

The typical lumbar vertebrae are the first four segments, so called because of their similarity, yet no two of them are found to be exactly alike.

A typical lumbar vertebra consists of a body, a neural arch and nine processes.

The descriptive parts of a typical lumbar vertebra are as follows:

One Body.      Two Laminae.      Four Articular Processes.

Two Pedicles.      Two Mammillary Processes.

One Spinous Process.

It will be noted that the mammillary processes are given here as separate descriptive parts. While they are a part of the articular processes, yet they should be described not only in connection with the articular processes, but as separate processes, for in reality they are separate.

### **The Body**

The body of a typical lumbar vertebra is very large, heavy and kidney shaped. It is composed of cancellous bone tissue,

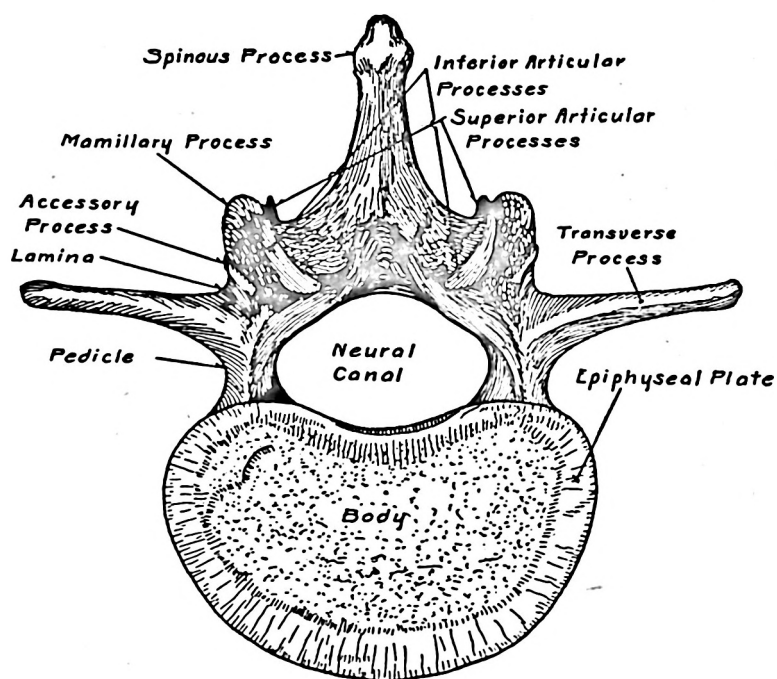


Fig. 53. Typical Lumbar Vertebra (2nd Lumbar).

the outer layer of which is compact bone perforated by numerous small openings called foramina, for the passage of nutrient vessels which supply the interior of the body.

The general description of the body of a lumbar vertebra would be very much the same as that of the bodies of the other regions of the spine. The bodies of the lumbar vertebrae, however, have no lips as do the cervical vertebrae. There are no facets or demi-facets as there are on the bodies of the dorsal vertebrae. The transverse diameter is greater than the antero-posterior width, while in the dorsal region it is just the reverse. In the dorsal region the antero-posterior width is greater than the transverse diameter, but in the lumbar region the antero-posterior width is about two-thirds of the transverse diameter.

It will be noticed that the body of the fifth is very much larger in circumference than that of the first, and that this change takes place gradually from the first to the fifth. The inferior surface of the body of a lumbar vertebra will be found to be larger in circumference than the superior surface. The inferior surface of the body of the first articulates with the superior surface of the body of the second, therefore the circumference of the superior surface of the second will be the same as that of the inferior surface of the first, and so on down the entire region. Thus the circumference of the bodies increase from the first to the fifth, inclusive.

#### **Anterior Surface.**

The anterior surface, also called the ventral surface, of the body of a typical lumbar vertebra is convex transversely, that is from side to side, and concave vertically, from above downward. The Anterior Common Ligament is attached to this surface.

**Posterior Surface.**

The posterior surface or dorsum of the body of a typical lumbar vertebra is straight vertically from above downward and slightly concave transversely, from side to side. This surface forms the anterior wall of the neural ring, converting the neural arch into a ring. In the posterior surface there is a large depression into which several of the smaller foramina open.

The pedicles arise from either side of the superior third of the posterior surface of the body.

**Lateral Surfaces.**

The lateral aspects of the body of a typical lumbar vertebra is rounded or, we might say, convex from before backward. The constriction around the anterior surface extends around the lateral surfaces, making them concave vertically, or from above downward. The Anterior Common Ligament extends around and is attached to the lateral surface.

**Superior and Inferior Surfaces.**

The superior and inferior surfaces of the bodies of the lumbar vertebrae are deeply concave to receive the convexity of the intervertebral discs. This convexity is deepened by the Epiphyseal Plates around the edges of the superior and inferior surfaces.

**Epiphyseal Plates.**

These epiphyseal plates are described the same as those on the superior and inferior surface of the dorsal vertebrae and the student is referred to that description.

### The Pedicles

The pedicles of a typical lumbar vertebra project backward from the superior of either side of the posterior surface of the body slightly diverging. These are relatively heavier than those of either the cervical or dorsal regions, but they are comparatively shorter. The superior surfaces are notched by the intervertebral notches, which are deeper than those in the superior surfaces of the pedicles of the dorsal region. The intervertebral grooves in the inferior surfaces are very deep. The grooves in the superior surfaces form the floor for the intervertebral foramina above, while the grooves in the inferior surfaces form the roof for the intervertebral foramina below. The pedicles are also called the roots of the intervertebral arches for they form the anterior portion of the neural arch.

### The Laminae

As has been previously stated, the word "lamina" means layer or plate but in the lumbar region the processes which are called laminae are not true to the name, for they are not as flattened as those of the other regions of the spine.

The laminae in the lumbar region are broad, short processes of bone which project almost vertically backward from the pedicles. While the pedicles diverge, the laminae converge and meet in the posterior line and complete the neural arch.

The laminae of this region do not overlay as those of the other regions, therefore they do not close up the neural canal at the posterior, but an opening is left which is closed in the recent state by ligaments and muscles. The lateral inferior surfaces are flattened to articulate with the superior articulating surfaces of the vertebra below and also the articulation of the mammillary processes.

### Transverse Processes

The transverse processes in the lumbar region arise at the junction of the pedicles with the laminae, but the attachment extends forward to the lateral surfaces of the pedicles. This, as well as the length of the transverse processes, varies and will be considered in the study of the separate lumbar vertebrae.

The transverse processes are also called the muscular processes. They increase in length from the first to the third, but decrease in length from the third to the fifth. They are quite frail and deeply located beneath the heavy lumbo muscles. Those of the lower vertebrae are heavier.

The general direction of the transverse processes is, of course, lateral from the neural arch, but in the middle lumbar region they point toward the posterior. This varies slightly with the separate segments and will be explained in the section on the comparative study of the lumbar vertebrae.

The transverse processes in the lumbar region are never used as levers upon which to adjust for the reason that these vertebrae are relatively hard to adjust. The transverse processes are comparatively frail so there is danger of breaking them. They are deeply located beneath the heavy lumbo muscles, making it quite impossible to palpate them in this region.

### Accessory Processes

The accessory processes are two small processes of bone found at the root of the transverse process, they project laterally and slightly downward. This process is not always present in the human body, but is well developed in the lower animals. Its function is to increase the area for the attachment of ligaments and muscles.

## Articular Processes

In the lumbar region the articular processes or zygapophyses are formed at the junction of the pedicles with the laminae the same as in the other regions of the spine, but they are larger and more powerful, and so formed as to be interlocking.

### Superior Articular Processes.

The superior articular processes, or Pre-zygapophyses, are formed at the junction of the pedicles with the laminae. They project upward and are attached to the pedicles anteriorly and to the laminae posteriorly. In addition to the regular articular process, such as is formed in the dorsal and cervical regions, there is a process known as the Mammillary Process.

The articulating surface is located on the posterior and medial aspect of this process, the plane being vertical. In some cases this articulating surface is divided into two parts, one corresponding to the surface in the dorsal region and the other formed on the medial surface of the mammillary process. These surfaces may be placed at right angles to each other. In most cases, however, the two surfaces coalesce forming a concave articulating surface. The mammillary processes correspond with the superior tubercles which are found on the lower dorsal vertebrae.

### Inferior Articular Processes.

The inferior articular processes, or Post-zygapophyses, are formed on the lateral sides of the laminae. They arise near the root of the spinous process and project downward. The articulating surfaces on these processes are oval in shape, straight from above downward and convex from side to side, the plane of the surface being perpendicular to a horizontal

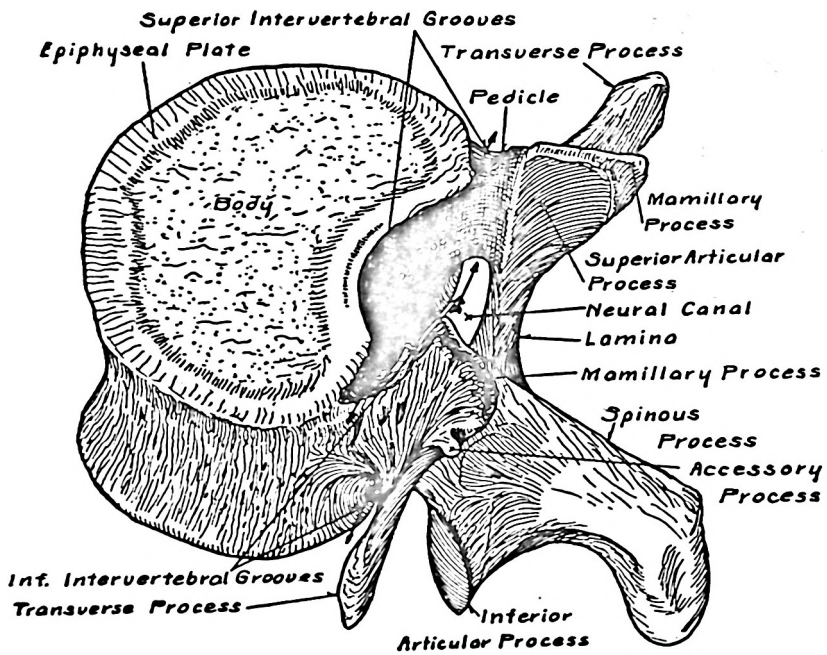


Fig. 54. Typical Lumbar Vertebra.

line. The surface which articulates with the surface on the mammillary process looks laterally away from the median line, while the other part of the surface looks toward the anterior. They vary in conformity with the variation of the superior articulating surfaces with which they articulate.

The inferior articular processes are set much closer together than the superior processes so that they fit in between the mammillary processes of the vertebra below when the vertebrae are in proper apposition; that is, when the vertebrae are superimposed in proper articulation with each other the inferior articular processes of one vertebra fit in between and are embraced by the superior articular processes of the vertebra below.

### Spinous Processes

The Spinous Processes in the lumbar region are, by far, the heaviest in the entire spine. They are formed by the junction of the laminae and are located in the posterior median line. They are thorn-like, composed of solid compact bone tissue, point straight toward the posterior and present a rough, clubbed extremity. Because of the broad and somewhat irregular extremity the spinous process often presents a slight longitudinal groove which may be detected upon palpation. When such is the case the spinous process is said to be bifurcated.

The spinous processes are placed in such a way that the superior border is just about on a line with the center of the body of the vertebra to which the spinous process belongs. In most of the specimens which we have examined the spinous processes were found to be directed downward but slightly at an angle varying from  $5^{\circ}$  to  $10^{\circ}$ .

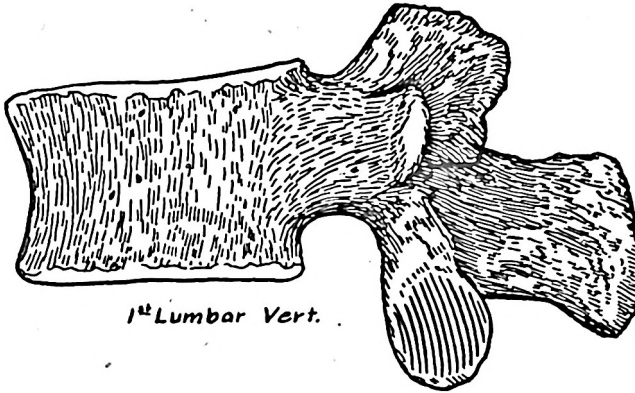
## A Comparative Study of the Lumbar Vertebrae

### First Lumbar Vertebra

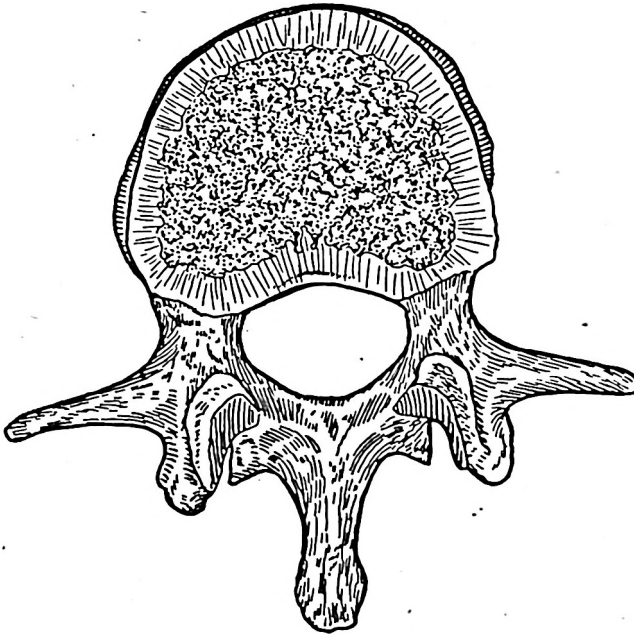
The twelfth dorsal vertebra being the transitional vertebra between the dorsal and lumbar regions leaves the first lumbar as a typical lumbar vertebra. Although it is typical of the region to which it belongs, yet there are many points that are different from the other lumbar vertebrae. By referring to the cut the student may observe many points of difference between the first and second. Although these points are small, yet they should be noted.

There is little difference between the bodies of the first and the second. The transverse width of the first is a little less than that of the second, but this is very slight. The pedicles and the laminae are very similar. The transverse processes of the first lumbar vertebra arises at the junction of the pedicles with the laminae and project laterally and slightly toward the posterior at an angle of about  $30^{\circ}$ . In the same cases these transverse processes are extremely short and may be no more than mere tubercles resembling those of the twelfth dorsal vertebra.

The articular processes of the first lumbar vertebra are very similar to those of the second, but the spinous process of the first is not quite as heavy as that of the second. It points toward the posterior with a slope toward the inferior at an angle of not more than  $5^{\circ}$ .



1<sup>st</sup> Lumbar Vert.



1<sup>st</sup> Lumbar Vertebra

Figs. 55, 56.

## Second Lumbar Vertebra

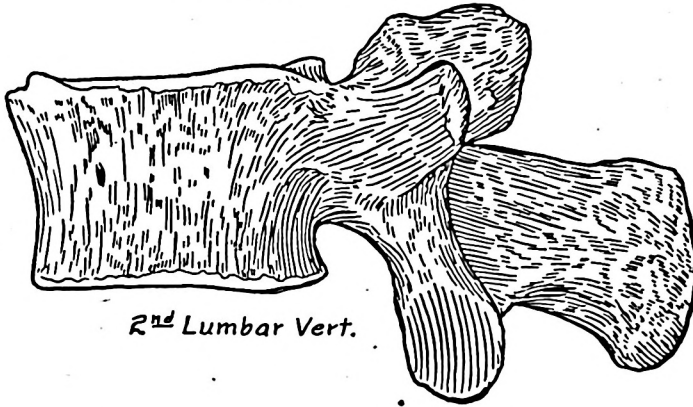
By studying the cut of the first and second lumbar vertebrae it will be observed that the greatest difference is found in the transverse processes. The spinous process of the second is a little thicker than that of the first. It can not be observed in the cut but in looking at the specimen it will be seen that the transverse width of the second is a little greater than that of the first. The inferior articulating surfaces are a little farther apart than those of the first.

The transverse processes of the second, which are directed toward the posterior at an angle of about  $30^{\circ}$ , are longer than those of the first. They arise at the junction of the pedicles with the laminae just the same as on the first, but we note here a tendency for the attachment to be farther toward the anterior, extending on to the pedicle. This makes the root of the transverse process of the second broader than that of the first. The transverse processes of the second are directed toward the posterior at an angle of about  $30^{\circ}$ .

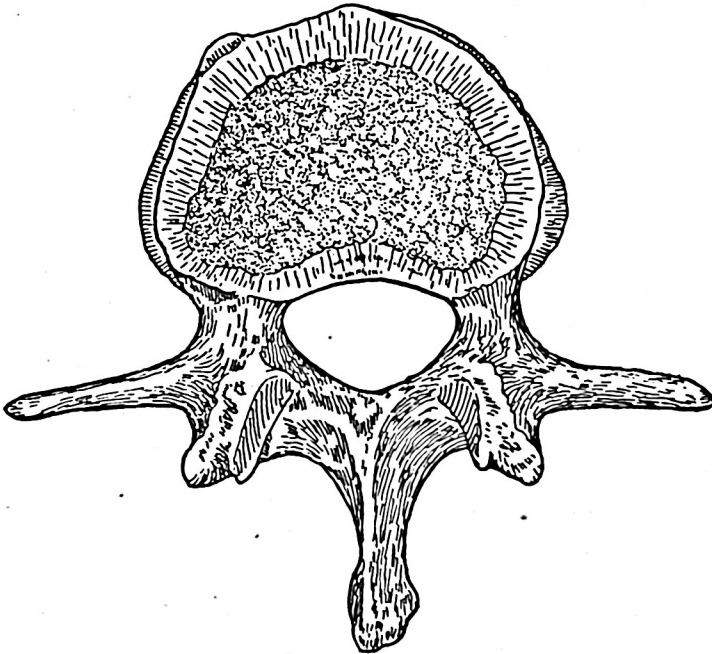
The spinous process of the second is a little heavier than that of the first and usually has a broader extremity. The angle toward the inferior is not more than  $5^{\circ}$ .

## Third Lumbar Vertebra

The third lumbar vertebra is in the exact center of the lumbar region. The transverse width of the body is just a little greater than that of the body of the second. The pedicles are not quite as long as those of the lumbar vertebrae above, therefore the neural ring is somewhat flattened from before backward. As a matter of fact the spinal canal gets smaller in the lower lumbar region. The laminae are a little heavier and the inferior articular processes are farther apart.



*2<sup>nd</sup> Lumbar Vert.*



*2<sup>nd</sup> Lumbar Vertebra*

Figs. 57, 58.

The transverse processes of the third lumbar are very long and slender and do not point toward the posterior quite as much as those above. The base extends forward over the lateral aspects of the vertebral roots. In some cases these processes are so long that they resemble the ribs in the dorsal region.

The spinous process of the third lumbar is usually about the longest in the lumbar region. It is located just about the same as those of the other lumbar vertebrae and placed at about the same angle.

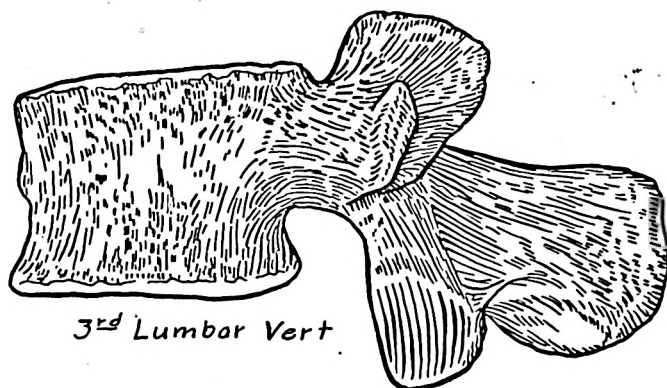
### Fourth Lumbar Vertebra

Taken in every respect the fourth lumbar vertebra is the largest segment in the spine. Although the circumference of the body of the fifth is greater than that of the fourth, yet the body of the fourth is much thicker than the body of the fifth. The transverse diameter of the body of the fourth is greater than that of the third.

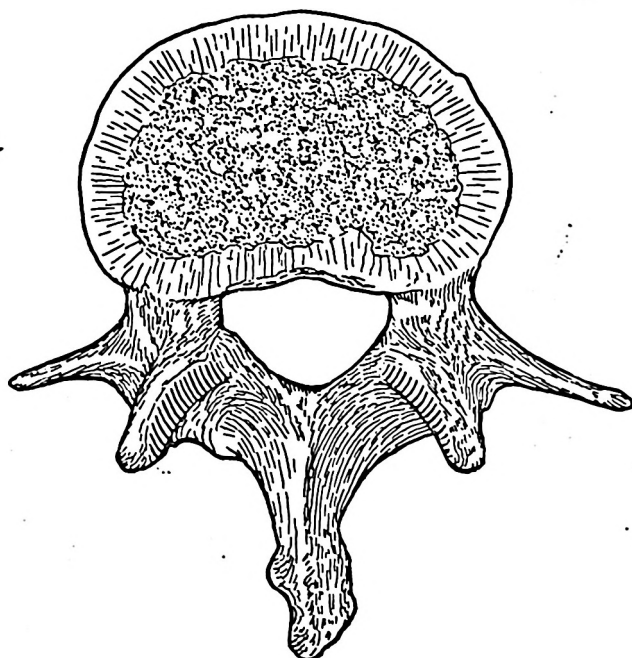
The transverse processes are usually not quite as long as those of the third, but are found to be heavier. They are formed at the junction of the pedicles with the laminae, but the base covers the entire lateral side of the pedicles. This gives the vertebra a rather massive appearance from the posterior.

The laminae are a little broader than those of the other lumbar vertebrae and the inferior articular processes are placed further apart than the superior processes and with the other lumbar segments this is just the reverse.

The spinous process of the fourth lumbar vertebra is not quite as long as that of the third, but the extremity is a little more regular and not quite so broad. It is located about the

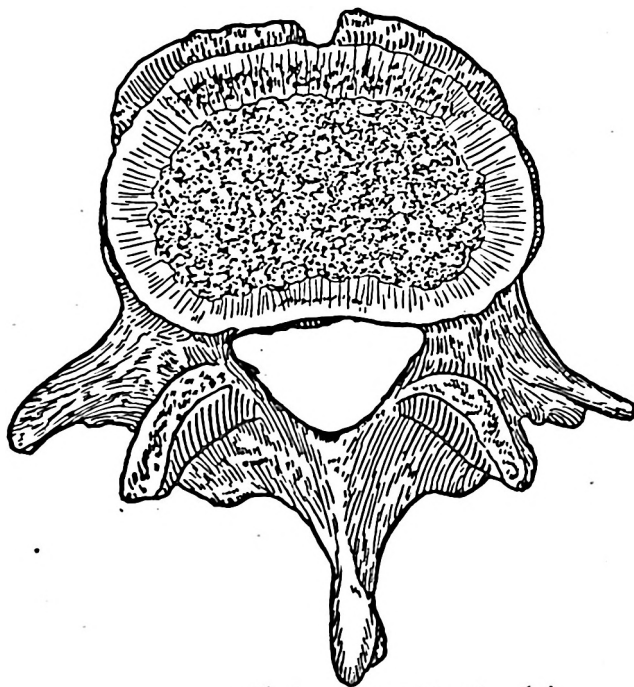
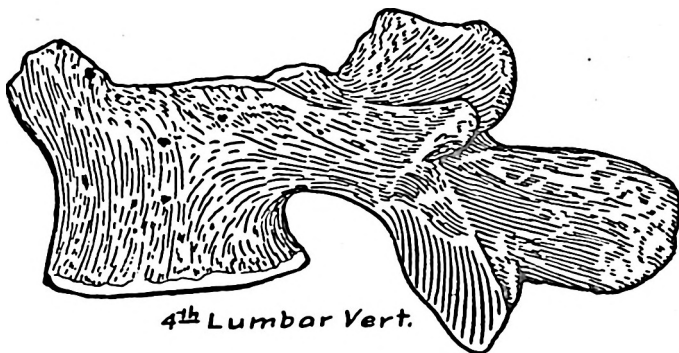


*3<sup>rd</sup> Lumbar Vert*



*3<sup>rd</sup> Lumbar Vertebro.*

Figs. 59, 60.



Figs. 61, 62.

same as those of the other lumbar vertebrae, at an angle of about 4°.

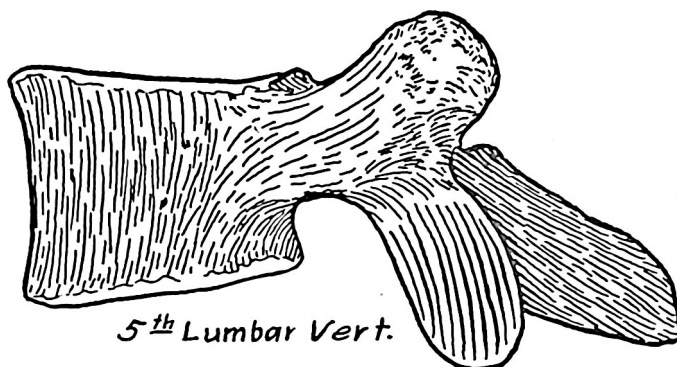
### The Peculiar Lumbar Vertebra

The fifth lumbar vertebra is given as the peculiar segment in the lumbar region, not because it presents any descriptive parts not found on the other vertebrae of this region, but because of the particular shape of the segment. Because of its position in the deep concavity of the anterior curve in the lumbar region, the body is decidedly wedge-shaped with the thick part at the anterior. The circumference of the body is greater than that of any of the other segments of the spine. The pedicles are very short and heavy, while the laminae are broad and flattened, being directed more toward the posterior than any of the other lumbar vertebrae. This is because the vertebra is thinner at the posterior, hence all the parts found at the posterior are thinner. The vertebral ring or neural ring is small and almost triangular in shape.

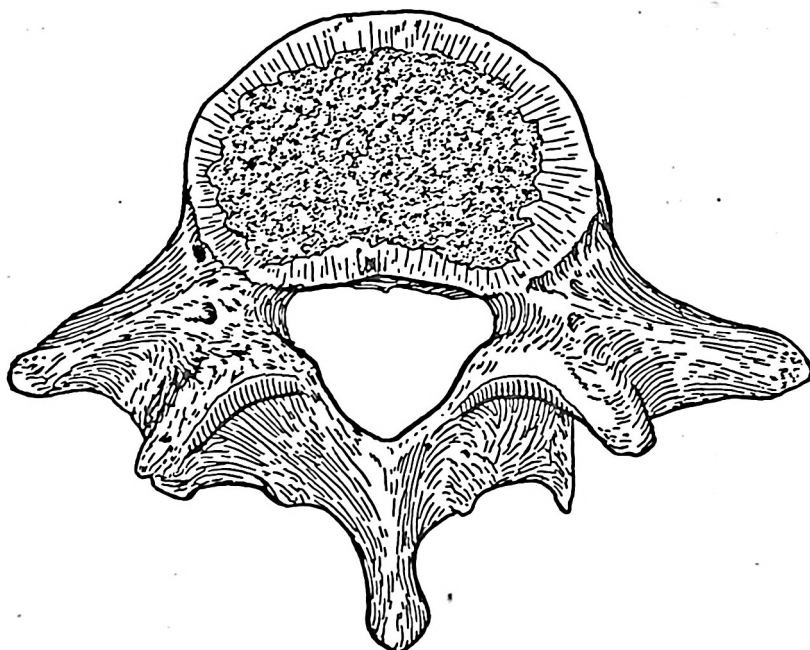
The transverse processes are short and very heavy. The base extends from the mammillary process forward to the posterior lateral surface of the body, covering the entire lateral surface of the pedicles. These processes in some cases are almost like alae.

The Articular Processes are larger than those of the other lumbar vertebrae and the mammillary processes are heavier. The inferior articulations are placed very far apart; they are much farther apart than the superior articulations. The articular processes articulate with the superior articular processes of the base of the sacrum, therefore they must be placed far apart.

The spinous process of the fifth lumbar is the smallest in the lumbar region. It is thinner and shorter than any of the



*5<sup>th</sup> Lumbar Vert.*



*5<sup>th</sup> Lumbar Vertebra.*

others and in some cases is quite hard to palpate. It is directed a little more toward the inferior and the extremity is rather pointed instead of being broad and irregular as are the others of this region.

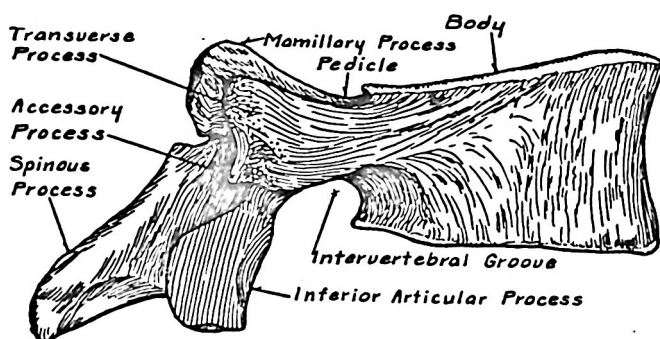


Fig. 65. Cut of the Fifth Lumbar—Lateral View.

PART V.

Vertebral Palpation

Misleading Irregularities of the Spinous  
Processes

Location of Intervertebral Foramina

Subluxations and the Resulting Change in  
Intervertebral Foramina

## Vertebral Palpation

Vertebral Palpation has been developed into a Science. There have been many factors which have entered into this development. A clear understanding of the philosophy of the development of the sense of touch has not been the least of these factors. There is no such thing as the development of the sense of touch without concentration. But there must be more than this, for in order to concentrate there must be something upon which to center the attention, and to "attend" is one of the highest accomplishments of the educated mind; but again, to be able to "attend" there must be something of interest which will attract and hold our attention.

A thing to be of interest must be somewhat understood, at least there must be an acquisition of understanding. Attention may be forced for a time to that which absolutely does not attract and in which we can find nothing of interest but this will be only for a brief time. Therefore, it becomes of paramount importance that our palpation be so attractive that our attention will be spontaneous. Then it becomes necessary that we have such a complete knowledge of the spine that we may know exactly what we are palpating from the interpretation of the vibrations produced in the touch corpuscles in the tips of the fingers.

We cannot see the different parts of a vertebra except by means of the X-ray, therefore we must know the spine so well that we can get a mental picture of the spine from our palpation. Now, in order to do this we must obtain from

the study of the specimen a mental picture of the spine with which to compare what we find under the palpating fingers. We must not only know every spinous process in the spine, but must know where every other process of the vertebra is from that spinous process.

The object of palpation is to locate the subluxations by palpating the spinous processes. The fact that a spinous process is not in the median line is not necessarily an indication of interference with transmission, it might be a bent spinous process. We palpate the spinous processes not so much to determine whether or not they are in the median line, but to determine the condition existing at the intervertebral foramina and if the palpation of the spinous process does not reveal the exact condition existing at the intervertebral foramina then the palpator has failed to accomplish the desired end. The tip of the spinous process being out of the median line would not cause inco-ordination in the body unless thereby the lumen of the foramen was made smaller and pressure thus produced on the spinal nerve.

Nerve tracing is a great asset to the Chiropractor, with the co-operation of the patient, to trace an impinged nerve from the point of exit at the spine to the periphery, or from the periphery back to the spine, thus proving "apriori" and "aposteriori" the cause of disease. Nerve tracing, however, is of no value unless you know where the nerve emits from the vertebral canal with reference to the spinous processes, for you cannot palpate the intervertebral foramen. The spinous processes must be relied upon and used as landmarks from which to locate the intervertebral foramina. The location of the intervertebral foramina varies in the different regions of the spine, therefore the location of each pair must

be considered separately. This is explained in the article on "Location of Intervertebral Foramina With Reference to the Spinous Processes."

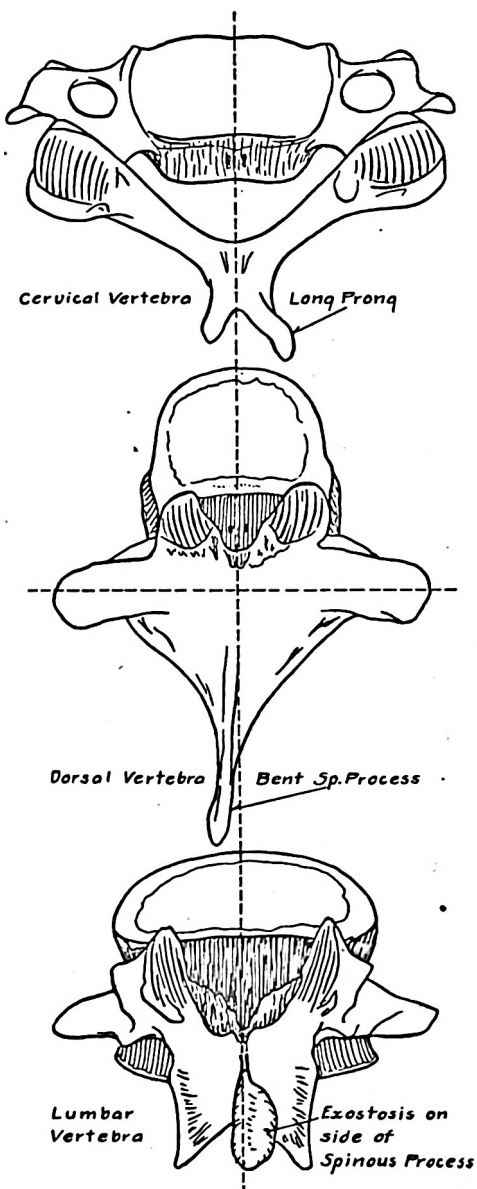
## Misleading Irregularities in the Spinous Processes

There are certain conditions that may obtain in the different regions of the spine that may prove misleading to the Chiropractor in the palpation of the vertebrae. These conditions vary in the different regions and should receive most careful consideration as the results depend upon the correct listing of the vertebra that is to be adjusted. These conditions and peculiarities may be summed up as follows:

### Cervical Region—Fig 66.

A careful study of the spinous processes is very necessary as we have seen from the study of the vertebrae that the spinous processes are not all the same. In the cervical region the spinous processes are bifid and herein lies the danger of mistake in listing the subluxations. There would be no great difficulty if the prongs of the bifurcations were all the same, but they are not. It is often found that the prong on one side will be longer than the prong on the other side. Attention is called to Fig. 66. This would give the palpator the impression of laterality on the side of the long prong when as a matter of fact the vertebra might be subluxated in the opposite direction.

In palpating in the cervical region, therefore, it is necessary to find the center of the bifurcation and make comparisons with this point for the center of the bifurcation of the spinous process is usually in the center of the vertebra.



Figs. 66, 67, 68.

Hence if the center of the bifurcation is in the median line in comparison with the vertebra above and the vertebra below the vertebra in question, it is not subluxated.

It is not always possible to palpate the center of the bifurcation but in the large majority of cases it is possible. In the few cases where this can not be done the Chiropractor has the use of Nerve Tracing and the Spinograph.

#### Dorsal Region—Fig. 67.

In the dorsal region where the spinous processes are not bifid but are long and slender the peculiarity which is likely to result in an erroneous listing of the vertebra is the bent spinous process. It is not uncommon to find bent spinous processes in the dorsal region and when we take into consideration the fact that the processes are very slender and are directed downward it can readily be seen that it is a very easy matter for them to become bent. A bent spinous process may be the result of a green stick fracture but more often they result from pressure upon the spinous process during childhood when the osseous tissue is more plastic.

It is often found that the vertebra is subluxated in the direction in which the spinous process is bent. This is particularly true if the process has been bent as a result of a green stick fracture, for the force that fractured the spinous process would be great enough to subluxate the vertebra.

#### To Determine a Bent Spinous Process in Dorsal Region.

See Figure 67.

If a vertebra palpated badly subluxated in the dorsal region and there is no incoordination in that meric zone and the nerves are not tender there is good reason to suspect a bent spinous process. To determine whether the spinous

process is bent or whether the vertebra is subluxated it is necessary to palpate the transverse processes and make comparison with the spinous process. If the distance between the spinous process and the transverse process on the left side is less than the distance between the spinous process and the transverse process on the right side, this indicates that the spinous process is bent toward the left. If the patient is fleshy or the back very muscular, it may be impossible to palpate the transverse processes, but in the majority of cases it will be possible to determine the bent spinous processes by the method just described. In case that this can not be done, it will be advisable to have a Spinograph made.

In some cases exostotic growths may be encountered in the dorsal region, but these are not of much consequence for when this condition obtains it will be so prominent that the Chiropractor will readily suspect such irregularities. In some cases there may be found an irregularity in the length of the laminae. This would give the same impression from palpation as a bent spinous process and would be handled in the same way. However, the spinograph would reveal the true condition.

#### **Lumbar Region.**

See figure 68.

In the lumbar region the spinous processes are heavy, broad, rather irregular and present a somewhat clubbed extremity. These processes are exceedingly heavy so that they are not often bent. It is often found that there will be small exostotic growths on the sides that may give the impression of a subluxation upon palpation. It is not possible to palpate the transverse processes in the lumbar region, but, usually, if the patient is made to sit erect the heavy muscles of the

back may be relaxed to such an extent that it is possible to palpate deep along the side of the process and, in that way, the trained Chiropractor will be able to determine the irregularity and not be misled. However, in this, the same as in other peculiarities, it is often necessary to resort to the Spino-graph in order to determine the exact condition.

It is often found that spinous processes in the lumbar region are listed bent when they are not bent, but the irregularity is the result of the lamina on one side being shorter than the one on the other side. In examining a great many specimens the author has found that irregularity in the length of the laminae in the lumbar region is much more prevalent than bent spinous processes.

## Location of the Intervertebral Foramina with Reference to the Spinous Processes

Fig. 69.

In order to make use of the art of nerve tracing it is necessary to locate the intervertebral foramina with reference to those parts of the vertebra which we palpate. The foramina superior to the atlas must be located with reference to the transverse processes but, with all the other vertebrae, the foramina are located in relation to the spinous processes.

This information is necessary that we may know which vertebra is subluxated and causing the tenderness of the nerve. Therefore, the student must study very carefully every vertebra in the spine and the relative position of the spinous process to the intervertebral foramina superior. The accompanying illustration, Fig. 69, shows each intervertebral foramen with a line drawn through the center out past the spinous processes. This shows the exact relative position of the spinous process to the intervertebral foramina. It will be observed that the lines are drawn at right angles to the surface of the back as this is the method that would be used in palpating and nerve tracing the patient.

The spine in this figure is not schematic but is a pen line drawing of a photograph from a specimen in the Osteological Studio. Great care has been exercised in the preparation of this illustration so that it might be absolutely correct.

### **Foramina Superior to the Atlas.**

In locating the intervertebral foramina superior to the atlas, it must be remembered that the atlas has no spinous process, therefore the transverse processes must be palpated and the intervertebral foramina located with reference to these transverse processes.

The intervertebral foramina superior to the atlas are about one inch laterally from the median line and a very little above a horizontal line drawn through the posterior arch of the atlas. Taking the transverse processes as land marks, the foramina superior to the atlas will be found about three quarters of an inch to the posterior and toward the median line of the neck.

### **Foramina Superior to the Axis.**

The intervertebral foramina superior to the axis may be located with reference to the spinous process of the axis. They will be found about three-eighths of an inch superior to a horizontal plane passing through the center of the spinous process and approximately one inch laterally from the median line forming an angle of about  $20^{\circ}$ . Or in other words, they are on a line with the extreme superior border of the spinous process of the axis. In relation to the transverse processes of the axis these foramina are about half an inch toward the median line.

### **Foramina Superior to the Third, Fourth and Fifth Cervical Vertebrae.**

From the third cervical vertebra, to the fifth lumbar inclusive, each intervertebral foramen is located between the pedicles of each two adjacent vertebrae, posterior to the bodies and anterior to the articular processes of the vertebral

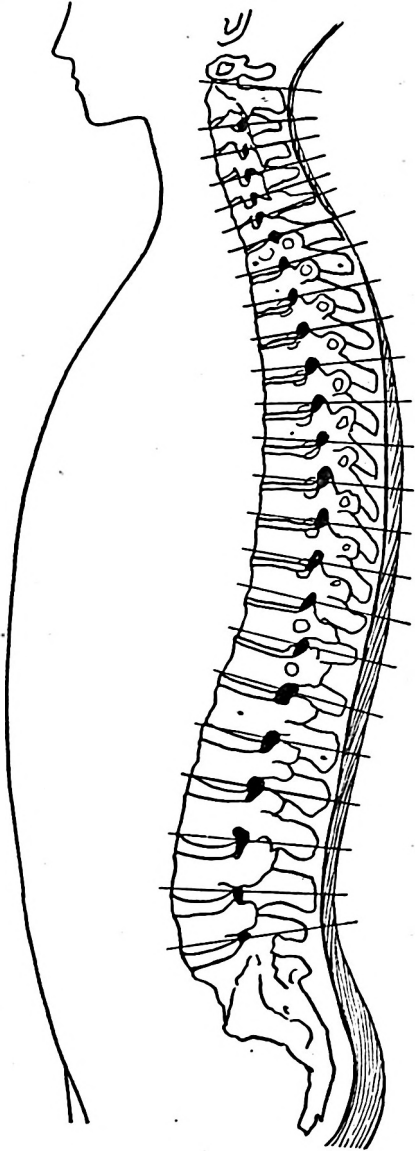


Fig. 69.

arches. They are just inferior to the transverse processes of the vertebra above and superior to the transverse processes of the vertebra below.

The intervertebral foramina superior to the third, fourth and fifth cervical vertebrae with reference to the spinous processes are in a plane passing horizontally through the extreme superior border of the spinous processes of the vertebra in question or possibly the first interspinous space above.

In nerve tracing, therefore, the point nearest the spine where pressure could be applied for the purpose of determining tenderness would be about an inch and a quarter from the median line and about a quarter to a half inch above the tip of the spinous process of the vertebra in question. A line drawn from the tip of the spinous process to the center of the intervertebral foramen would form an angle of about  $20^{\circ}$  to a horizontal plane.

#### **Foramina Superior to the Sixth Cervical Vertebra.**

The intervertebral foramina superior to the sixth cervical vertebra are found in a plane passing horizontally through the extreme inferior border of the spinous process of the fifth cervical vertebra. In nerve tracing the tenderness will be found about an inch and a half from the median line on either side. A line drawn from the spinous process of the sixth cervical vertebra to the center of the intervertebral foramen above would be at an angle of about  $30^{\circ}$  to a horizontal plane.

#### **Foramina Superior to the Seventh Cervical Vertebra.**

The intervertebral foramina superior to the seventh cervical vertebra are on a line with the center of the spinous process of the sixth cervical vertebra. In comparison with the spinous process of the seventh they are about an inch to the superior. In locating the tender nerves superior to

the seventh cervical vertebra pressure would be applied about an inch and a fourth laterally from the median line and about an inch to the superior.

#### **Foramina Superior to the First Dorsal Vertebra.**

As the dorsal region is approached the intervertebral foramina are found to be farther above the spinous process of the vertebra to which they belong. Those superior to the first dorsal vertebra are found on a line with the superior border of the spinous process of the seventh cervical vertebra. They are not quite as far to the superior from the spinous process as they are farther down the dorsal region. This is because the spinous process of the first is not as long as the spinous process of the middle dorsal region and also because it does not point so much toward the inferior. They are just superior and slightly anterior to the transverse processes of the first dorsal vertebra and directly inferior to those of the seventh cervical.

In locating the tender nerves superior to the first dorsal vertebra, pressure would be applied at a point about an inch and a fourth on either side of the median line and on a horizontal plane with the superior border of the spinous process of the seventh cervical vertebra.

#### **Intervertebral Foramina Superior to the Second Dorsal Vertebra.**

With the second dorsal vertebra we find the intervertebral foramina a little farther above the spinous process than those of the first, but not as far to the superior as those farther down. The foramina superior to this segment of the spine are found on a level with a horizontal plane passing through the extreme superior border of the spinous process of the

vertebra next above which would be the first dorsal. In nerve tracing the pressure should be applied in this plane about an inch and a half from the median line.

#### **Intervertebral Foramina in the Typical Dorsal Region.**

From the third to the ninth dorsal vertebra, inclusive, we find that there is but little variation in the relative position of the intervertebral foramina from the spinous processes. In this region of the spine the intervertebral foramina will be found to be on an exact line with the second interspinous space above the spinous process of the vertebra in question. To illustrate: The intervertebral foramina superior to the fifth dorsal vertebra are on a line with the interspinous space between the spinous process of the fourth and that of the third dorsal vertebra, which would be the second interspinous space above the spinous process of the fifth dorsal. In other words the foramina are found in a plane passing horizontally through the second interspinous space above the spinous process of the vertebra in question.

In finding the tender nerves it is necessary to measure out an inch and a half from the median line in order to be out far enough from the spine so that the pressure is not placed on the transverse process, the apex of which is about one inch from the median line of the vertebra.

#### **Intervertebral Foramina in the Lower Dorsal Region. Tenth Dorsal Vertebra.**

The spinous process of the tenth dorsal vertebra is not as long as that of the dorsal vertebrae above, neither is it directed so much toward the inferior. This makes a difference in the relation between the intervertebral foramen and the spinous process. The intervertebral foramina superior to the

tenth dorsal vertebra are on a line with the lower third of the second interspinous space above.

#### **Eleventh Dorsal Vertebra.**

The intervertebral foramina superior to the eleventh dorsal vertebra are in a plane passing horizontally through the superior border of the spinous process of the tenth vertebra. Thus we see that as the spinous processes become shorter and point more toward the posterior, the intervertebral foramina are not so far to the superior.

#### **Twelfth Dorsal Vertebra.**

The twelfth dorsal vertebra is one of the transitional vertebrae of the spine, therefore it takes on the characteristics of two of the regions of the spine. The spinous process is very similar to those in the lumbar region especially so far as direction is concerned. The intervertebral foramina superior to this vertebra are found on a line with the center of the spinous process of the eleventh dorsal. This is the same as in the lumbar region.

In nerve tracing in the dorsal region the student must ever keep in mind the change in the spinous processes in the different parts of the dorsal region. In the upper dorsal and lower dorsal region the intervertebral foramina are not so far above the spinous processes as they are in the middle dorsal region where they are on a line with the second interspinous space above the vertebra in question.

#### **Intervertebral Foramina in the Lumbar Region.**

It is not necessary to locate each pair of intervertebral foramina in the lumbar region for they are all the same. The location is more constant in this region than in any other

region of the spine. In nerve tracing in the lumbar region it is necessary to measure out from the median line farther than in the other regions for the transverse processes in this region are somewhat longer.

The intervertebral foramina in the lumbar region are found to be in a plane passing horizontally through the exact center of the spinous process of the vertebra next above the spinous process of the vertebra in question. To locate the tender nerves superior to any lumbar vertebra measure out about an inch and three-fourths on either side from the center of the spinous process of the vertebra next above. This will give the location of the spinal nerve superior to that lumbar vertebra.

## Subluxations and the Resulting Change in Intervertebral Foramina

The term, subluxation, is one that is applied to a vertebra that has lost its proper juxtaposition with the one above and below. It is less than a luxation and less than a dislocation. The prefix "sub" means "slightly; less than normal; almost; nearly." "Luxate" means "to remove from its proper place." "Subluxated," "slightly removed from its proper place." The term, "juxtaposition" means proper apposition. Therefore a subluxation is a condition where two or more adjacent vertebral articulating surfaces have lost their juxtaposition.

Any abnormal position of a vertebra that changes the shape or the size of the intervertebral foramen, thus changing the shape and size of the spinal nerve, will interfere with the carrying capacity of the nerve and thus interfere with the transmission of the mental impulses through that nerve and produce incoordination in the organs that are supplied with impulses by that spinal nerve.

The palpation of the spinous process is of no value whatsoever unless the position of that spinous process reveals the condition existing at the intervertebral foramen. If the spinous process of a vertebra is out of the median line, it will cause no incoordination in the body but if the position of the spinous process indicates a change in the size or shape of the intervertebral foramen, valuable information has been gained, for we know that this change in the foramen will interfere with the carrying capacity of the nerve resulting in incoordination in the body.

There is no way of determining accurately which nerve is impinged by the direction of the spinous process, but the following general rule will be of some assistance in making analyses. When a vertebra is subluxated in two directions only and those directions are posteriority and laterality, the greatest tenderness in nerve tracing will be found to be on the nerve superior on the side of the laterality. We cannot depend upon this rule in every case for it often happens that we have a combination of directions difficult to detect by palpation, which might relieve the pressure on the nerve superior on the side of the laterality and produce pressure on the one superior on the opposite side of the laterality or even on the nerves inferior to the vertebra that is subluxated.

The greatest change in the size of an intervertebral foramen is caused by the superior articular processes being thrown forward. If the vertebra is subluxated toward the posterior and superior, the superior articular processes will be thrown toward the anterior and will occlude the pair of foramina superior, while very little change will take place in the foramina inferior.

If the vertebra is subluxated posteriorly and laterally, the greatest change will be in the foramen superior on the side of the laterality while the next greatest change will be in the foramen inferior on the opposite side. This holds good only with posteriority and laterality.

If there is posteriority, laterality and superiority, the greatest change will be in the two superior foramina; the foramen inferior on the side opposite to the laterality may be changed but little.

When the vertebra is subluxated toward the posterior and the inferior, the posterior superior margin of the body of the vertebra will be thrown toward the posterior thus

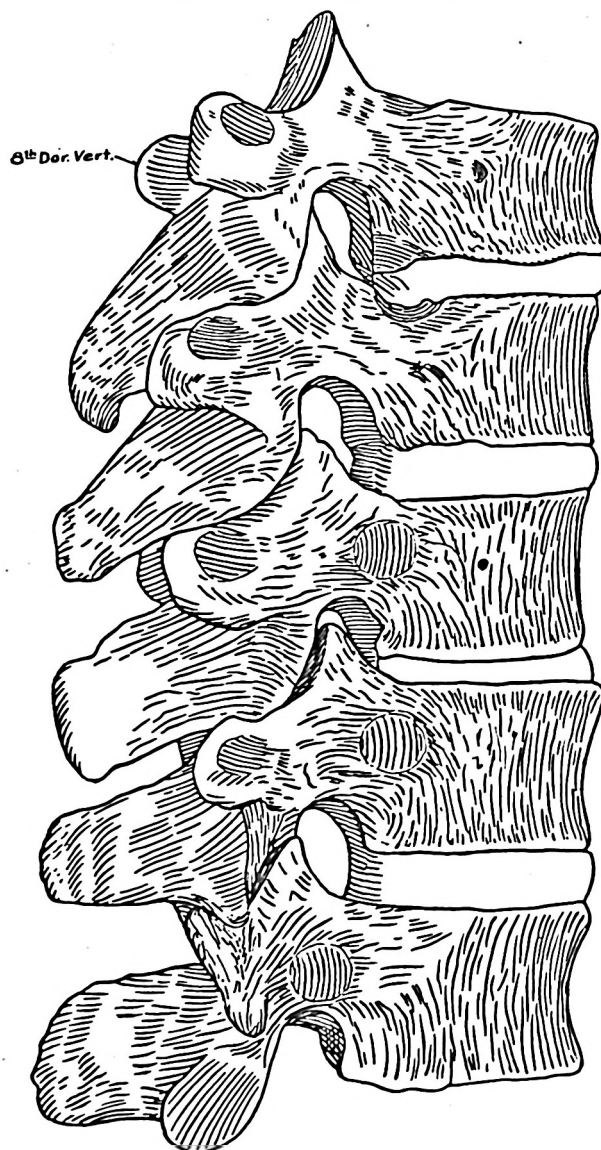


Fig. 70. Lower Dorsal Region Showing Subluxation and the Change in Intervertebral Foramina.

changing the size of the foramina superior to the vertebra in question. The inferior foramina are changed when the pedicles of two adjacent vertebrae are brought closer together.

With a posterior, lateral, and inferior subluxation the greatest change in the intervertebral foramina will be found to be in the foramen inferior on the side opposite to the laterality. This change is brought about by the position of the superior articular processes of the vertebra next below. There will also be a change in the foramen superior on the side of the laterality and also on the foramen inferior.

It must be remembered that the Chiropractor depends upon the palpation of the spinous processes and in some cases the transverse processes, that there might be a very slight rotation of the body of the vertebra that could not be detected by palpating either the spinous processes or the transverse processes and yet this rotation might be sufficient to change the pressure to another nerve. So there is no infallible rule to be followed.

The combination of directions involved in a subluxation, such as slight rotation of the body, tipping or tilting of the vertebra, depends upon the location of the fulcrum upon which the movement takes place. Therefore, it is impossible in some cases to determine just the combination of directions involved without the Spinograph, or X-ray picture of the spine.

It is absolutely essential that the adjuster have a correct mental picture of the subluxation before a proper adjustment can be given. While a subluxation may be corrected by an adjustment in which there is not exactly the proper combination of directions of the adjustic force, yet the subluxation may be adjusted with much less force and more readily when there is an exact combination of directions

in the adjustic move that will reverse the subluxated position of that vertebra.

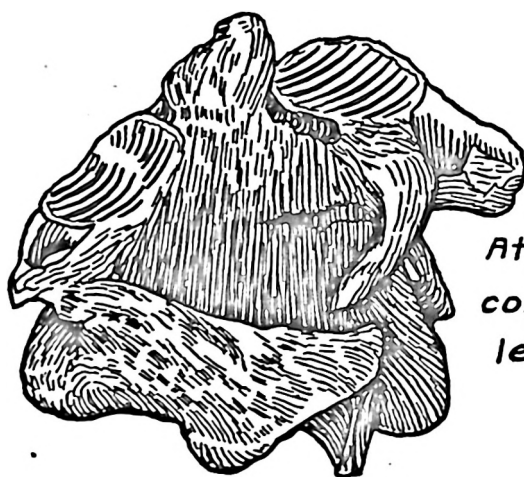
While it is impossible to determine the exact ratio of directions, yet it is possible to get a mental picture, reasonably correct, so that one can get the combination of directions as nearly exact as is possible for the trained mind of the Chiropractor. We know that it is much easier to move a vertebra when the force is applied in exactly the proper direction, just the same as a block placed in a pile with other blocks above and below, will move easier if the force is applied in an exact plane with the opposing surfaces of the blocks.

It is advisable that the Chiropractor study carefully the Spinograph plate before adjusting the subluxations, not only for the purpose of listing the subluxations, but also for the purpose of determining the degree to which the vertebra is subluxated in the several directions and the ratio of these directions.

If a vertebra is subluxated very slightly to the posterior with very great laterality and the adjustment is given as though there was more posteriority than laterality, the results will not be as good as if the adjustment is given according to the degree in which the vertebra is subluxated. This is one reason why we get better results in some cases than in others. One adjuster may get better results than another because he has a better mental picture of the subluxation and having a better mental picture, he sees the relation of the different directions.

Let us not forget that the structures attached to the vertebrae are living tissue in which intelligent force is being expressed and even though the adjustic force is not applied in exactly the proper direction, Innate Intelligence is capable

of using the vibrations to an advantage in bringing the subluxated vertebra back to its proper position. Innate Intelligence can do this much quicker and with greater ease when the adjustic force is applied in exactly the proper direction.



*Anomaly.  
Atlas & Axis  
combined on  
left Side*

Fig. B

**PART VI.**

**Sacrum**

**Coccyx**

**Rotated Sacrum**

**Subluxated Ilii**

**Tilted Pelvis**

## The Sacrum

The Sacrum is a triangular shaped bone wedged in between the two innominate bones. The base, which is directed upward, articulates with the fifth lumbar vertebra; the apex, which is directed downward articulates with the coccyx. The Sacrum was considered as a sacred bone by the ancients. They supposed that the soul resided in this bone, hence the name, Sacrum.

During childhood this bone consists of five segments separated by discs of hyaline cartilage which ossify about the time of puberty causing a coalescing of the segments so that in adult life the sacrum is one solid bone. For this reason the sacrum is spoken of as a false vertebra.

### Base—Fig. 71.

The superior surface of the base of the sacrum is very much like the superior surface of a true vertebra. There are, however, a few modifications. The superior surface of the body of the first segment of the sacrum is the same as the superior surface of the body of a lumbar vertebra and is the same in size and shape as the inferior surface of the body of the fifth lumbar vertebra with which it articulates. There is an intervertebral disc between these two surfaces. Occasionally it will be found that the fifth lumbar vertebra has become ankylosed to the base of the sacrum or in some cases the two vertebrae become coalesced the same as the segments of the sacrum.

*Superior Surface of Base of Sacrum.*

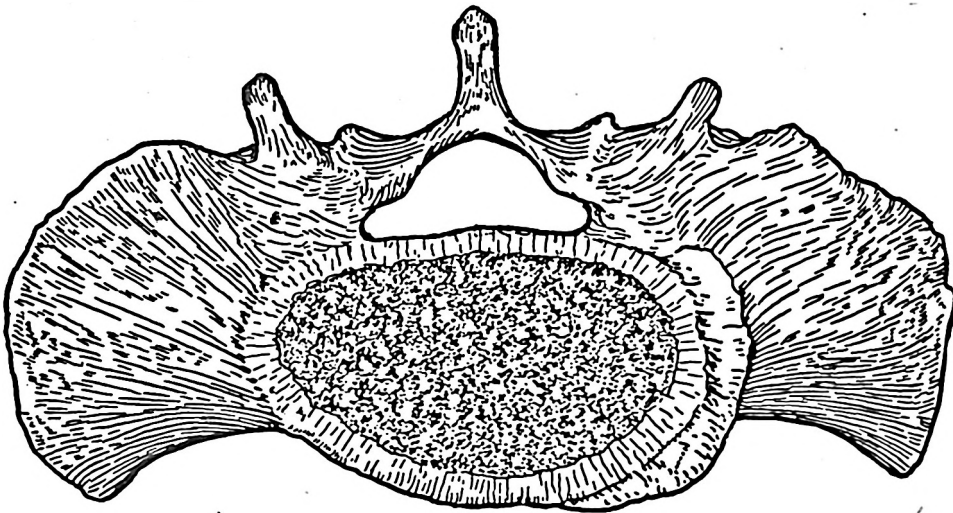


Fig. 71. Superior Surface of Base of Sacrum.

It will be remembered in the description of the fifth lumbar that the transverse processes are very broad and extend toward the anterior at the base covering the entire lateral sides of the pedicles. So it is with the base of the sacrum, the transverse processes are developed into very broad processes projecting laterally from the body forming what is known as the lateral masses. They proceed toward the anterior and slightly downward forming the alae of the sacrum. The pedicles are very short. The lateral masses of the sacrum are formed by the fusion of the transverse processes, the processes representing the ribs in the dorsal region.

The anterior margin of the superior surface of the body of the first segment being so much wider than the balance of the body, forms a projection which is called the PROMONTORY.

#### Posterior Surface.

The posterior surface of the sacrum is convex from above downward and also from side to side. It is very rough and presents many tubercles, depressions and eight foramina, four on each side of the median line.

In the posterior median line will be observed a tubercular ridge. This ridge is the remains of the spinous processes of the first three or four segments which have fused at the same time the segments coalesce. Usually the spinous process of the first segment is quite well developed while there are none at all on the last two. On either side of this tubercular ridge is a groove called the Sacral Groove, the floor of which is formed by the fused laminae of the four upper segments. Just lateral to this groove will be found another tubercular ridge. These ridges are formed by the fusion of the articular processes on each side. The ridge which they form is almost un-

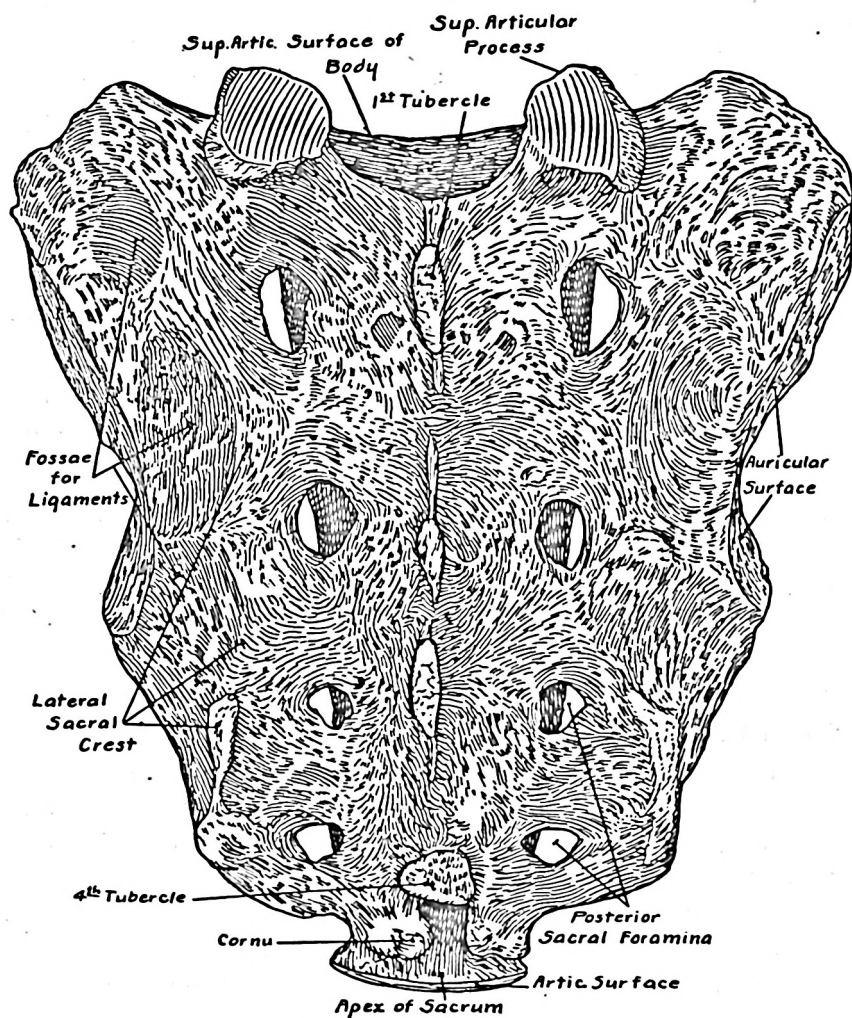


Fig. 72. Posterior View of Sacrum.

noticeable but it marks the sight of the former articulations between the vertebral arches of the segments of the sacrum.

On each side of the tubercular ridge formed by the articular processes are the posterior sacral foramina. These will be described later. Just laterally from the posterior sacral foramina on either side will be observed quite a prominent ridge which is formed by those parts of the sacrum which are homologous to the true transverse processes of the lumbar vertebrae.

The laminae of the last two segments of the sacrum fail to meet in the posterior median line. This leaves an opening at the posterior which exposes the sacral canal but the aperture is covered with ligaments in the recent state. This opening is called the *Hiatus Sacralis*. On either side of this opening the tubercles corresponding to the articular processes are formed on the edge of the undeveloped laminae. The tubercles formed by the inferior articular processes of the last segment of the sacrum project downward and form the *Sacral Cornua* which articulate with the cornua of the coccyx.

#### **Sacral Canal.**

The sacral canal is a canal passing downward through the center of the sacrum. It is formed by the posterior surface of the bodies of the segments of the sacrum and the arch formed by the pedicles and laminae. It extends the entire length of the sacrum but ceases to exist as a bony canal at the fourth segment. From this point to the apex the posterior wall is formed by the ligaments that are attached to these parts.

This canal is somewhat triangular in shape but toward the inferior it becomes very much flattened antero-posteriorly.

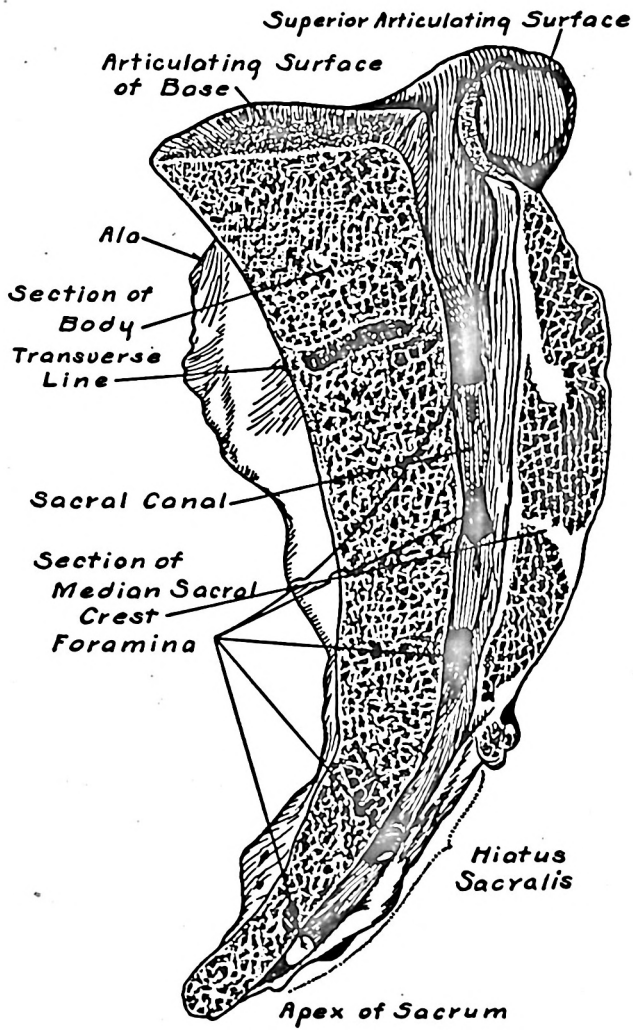


Fig. 73. Longitudinal Section of Sacrum.

It follows the curve of the sacrum and from it the intervertebral foramina are given off laterally. The openings which correspond to the intervertebral foramina in the true vertebrae pass downward laterally, four on each side of the sacral canal. These open into another canal from which sacral foramina are given off posteriorly and anteriorly.

The sacral nerves are transmitted from the spinal canal through the intervertebral foramen into this canal where they divide into the anterior and the posterior sacral nerves and pass out through the anterior and posterior sacral foramina.

In adult life it is impossible for the segments of the sacrum to become subluxated, although the sacrum as a whole may be subluxated with relation to the fifth lumbar or the ilii. During childhood, before the segments have become coalesced, the separate segments may become subluxated and produce pressure on the sacral nerves by changing the size of the sacral foramina, either posterior or anterior; or the subluxation might change the shape and size of the intervertebral foramen where the nerve leaves the sacral canal before it is divided into the anterior and posterior sacral nerves. When such a subluxation occurs during childhood the adjustment should be given just the same as with a true vertebra. It is very essential that the segments of the sacrum of the child be palpated and kept in proper alignment, for if a segment should become subluxated during childhood and allowed to remain in that position until after the segments become united, it would be impossible to correct the condition. This may account for some abnormalities in these zones that will not yield to adjustments. The student must remember, however, that a subluxation of a segment of the sacrum during childhood is rather an unusual thing.

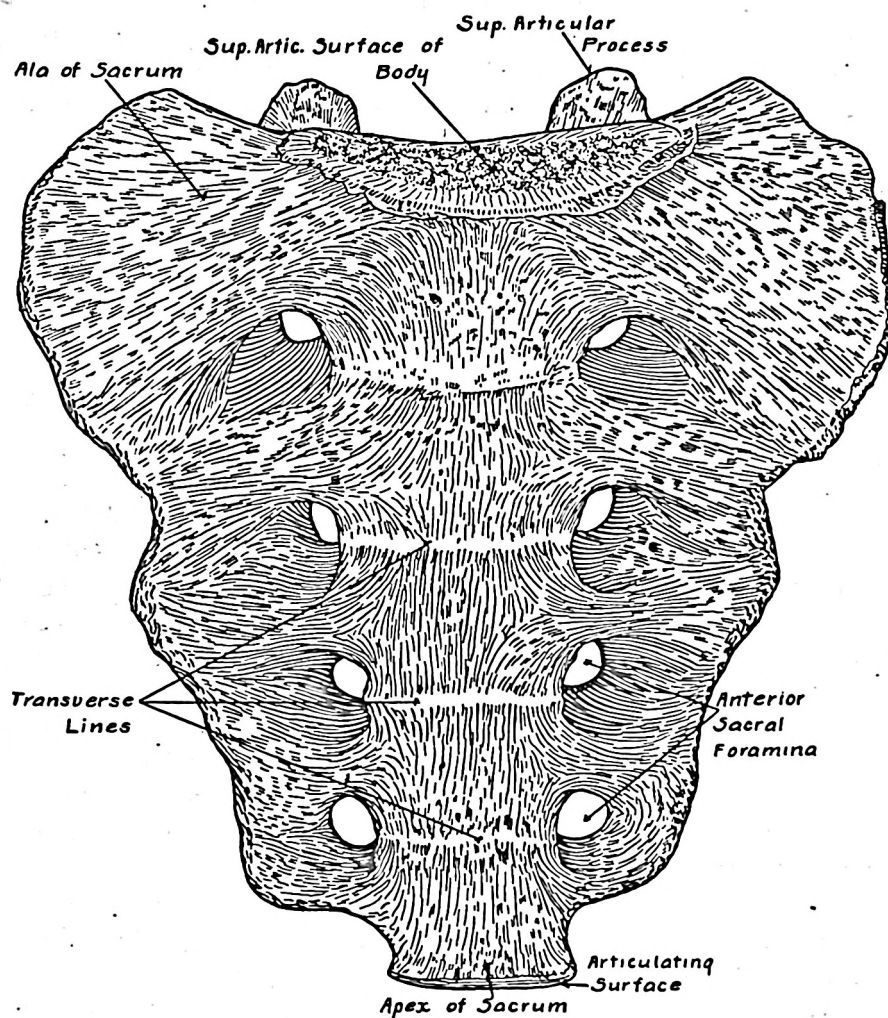


Fig. 74. Anterior View of the Sacrum.

Illustration No. 73 is a longitudinal section of the sacrum showing the sacral canal and the foramina as they open out of this canal transmitting the sacral nerve from the sacral canal before the nerve has divided into the anterior and posterior sacral nerves. Attention is called to the cancellous bone tissue of the bodies of the sacrum also the line showing the site of the intervertebral discs. This cut is a pen line drawing of a specimen in the P. S. C. osteological studio.

#### **Anterior Surface.**

The anterior surface of the sacrum is concave from above downward and slightly concave from side to side. This surface is comparatively smooth. In the adult sacrum the ossified discs are marked by transverse ridges passing across the central part. The spaces between the ridges correspond to the bodies of the sacral vertebrae. The alae which are plainly seen from the anterior make the sacrum decidedly wider across the first segment. Then there is a gradual narrowing of the first and the second segments down to the center of the third segment where it again increases in width. This increase marks the ending of the auricular articulating surface on the lateral sides of the sacrum. From the center of the body of the third sacral segment there is a gradual decrease in the transverse width down to the apex of the sacrum, with the exception of a point directly opposite the center of the body of the fifth segment where there is a slight increase in width. The increase in the lateral width at these two points makes the lateral edges rather irregular in shape but the general shape of the sacrum is that of a triangle.

On either side of the fused bodies and opposite the transverse ridges formed by the ossified discs are the anterior sacral foramina for the passage of the anterior sacral nerves.

The angle of the concavity from above downward is most acute at the center of the body of the third segment. The curve below this point is very much greater than from the base of the sacrum down to this point. Thus the sacrum helps to form the primary curve in the lower portion of the spine.

### **Lateral Surfaces.**

The lateral surface of the sacrum reveals the articulating surface, the rough surface for the attachment of the ligaments, and the thin edge for the attachment of the lower segments. The auricular articulating surfaces are so named from their resemblance to the external ear. They afford the articulating surface for the ilii. This surface is formed on the sides of the lateral masses of the sacrum from the first segment to about half of the third segment. These surfaces are very rough and irregular with a depression in the upper portion and also one in the lower portion of the articulating surface. These surfaces are attached to the articular surfaces of the ilii by powerful ligaments.

Just posterior to the auricular articulating surfaces and toward the median line is a very rough area which slopes backward and inward. This area does not extend below the auricular articulating surfaces. There are three depressions, a superior, an inferior and a middle. The superior depression is the deepest of the three.

From the center of the third segment of the sacrum to the apex, the lateral edges of the lateral masses are nothing more than thin lines. At the center of the body of the fourth segment, these lines make sharp turns medially and pass directly to the center of the body of the fifth segment.

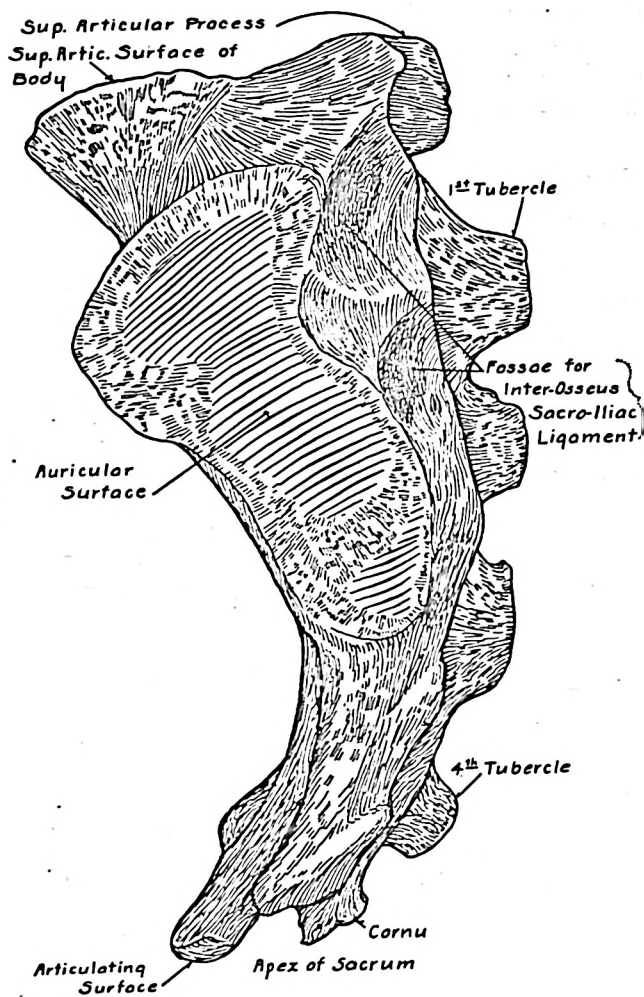


Fig. 75. Lateral View of Sacrum.

**Apex.**

The apex of the sacrum is formed chiefly by the inferior surface of the body of the last segment which articulates with the body of the first segment of the coccyx. This segment is very small and the inferior surface shows practically no lateral masses. The cornua of the sacrum may project far enough to the inferior to be seen when viewing the inferior surface. The apex of the sacrum articulates with the base of the coccyx.

## Coccyx

The coccyx was so named by the ancients because it resembles a cuckoo's beak in shape. It consists of four or five segments which are rudimentary vertebrae. The segments of the coccyx like those of the sacrum coalesce about the age of puberty and form one solid bone.

Superiorly the coccyx articulates with the apex of the sacrum by means of a fibro cartilage. The first segment is larger than the other segments and is about twice as broad as it is long. From the posterior surface extending upward are two processes of bone called the cornu of the coccyx which extend up over the posterior surface of the last segment of the sacrum and join the cornu of the sacrum. There is a slight projection laterally from either side of this first segment which represents the transverse process. The cornu of the coccyx with those of the sacrum form the foramina for the passage of the fifth pair of sacral nerves. These foramina are the last of the series of intervertebral foramina in the spinal column.

The second segment of the coccyx is not so well formed as the first. There are traces of the transverse processes and also of the vertebral roots. The balance of the segments are mere rudimentary oval shaped processes of bone. The first segment often remains separated from the second by means of a cartilage, but more often the segments all coalesce about the age of puberty.

The posterior surface of the coccyx is convex from above downward. There are transverse constrictions on the pos-



Fig. 76. Posterior View of the Coccyx.

terior surface and also in the lateral sides which show the line of the original demarkation between the segments.

The anterior surface is concave from above downward and somewhat smoother than the posterior. Each segment of the coccyx is developed from a separate center of ossification.

The coccyx often becomes subluxated and if so will cause inco-ordination either by mechanical obstruction or by interfering with the transmission of mental impulses by pulling on the final termanilae of the spinal cord. The most common direction in which it is subluxated is the anterior. This may cause obstructive constipation or it may, by lessening the pelvic outlet, interfere with parturition in the female. The coccyx is subluxated toward the anterior because in the majority of cases the subluxating force is usually directed from the posterior. If it is very badly subluxated it is very likely to become ankylosed to the apex of the sacrum. When this condition obtains it is necessary to break the ankylosis and in that case the calcarous matter of the coccyx will be absorbed and it is then spoken of as having been dissolved. Many cases are found where the coccyx has been broken off and dissolved.

The nerves do not pass through a canal of the coccyx as with the sacrum but they pass down over the posterior surface.

## Rotated Sacrum

Figure 77 shows a rotated sacrum. It is a straight superior view of the pelvis of a specimen in the P. S. C. Osteological Studio. This illustration shows a sacrum that is posterior on the left side. A similar condition would be determined by palpating the sides of the sacrum and finding that the left side is more prominent than the right. In palpating a case of this kind great care must be exercised that the ilium is not listed posterior instead of the sacrum, which is posterior on the one side. This subluxation might, unless extreme caution is used, be mistaken for a right ilium posterior, for it will be found that the distance from the side of the sacrum to the posterior superior spine of the ilium on the right side is greater than the distance from the side of the sacrum to the posterior superior spine of the left ilium. No such mistake will be made if the palpator is careful to compare the rudimentary spinous process of the first segment of the sacrum with the spinous process of the fifth lumbar vertebra. If the spinous processes of the segments of the sacrum are out of the median line, as indicated in the drawing, this is evidence that the sacrum is rotated and that the ilii are not subluxated.

The student should study this illustration very carefully and form as perfect a mental picture as is possible for many of these conditions will be met in the average practice. It should be noted that the relation between the ilii is not disturbed and that to correct the condition it would be necessary

to get a point of contact on the left side of the sacrum near the sacro-iliac articulation about on a line with the rudimentary spinous process of the first segment of the sacrum. The adjustic force should be directed straight toward the anterior.

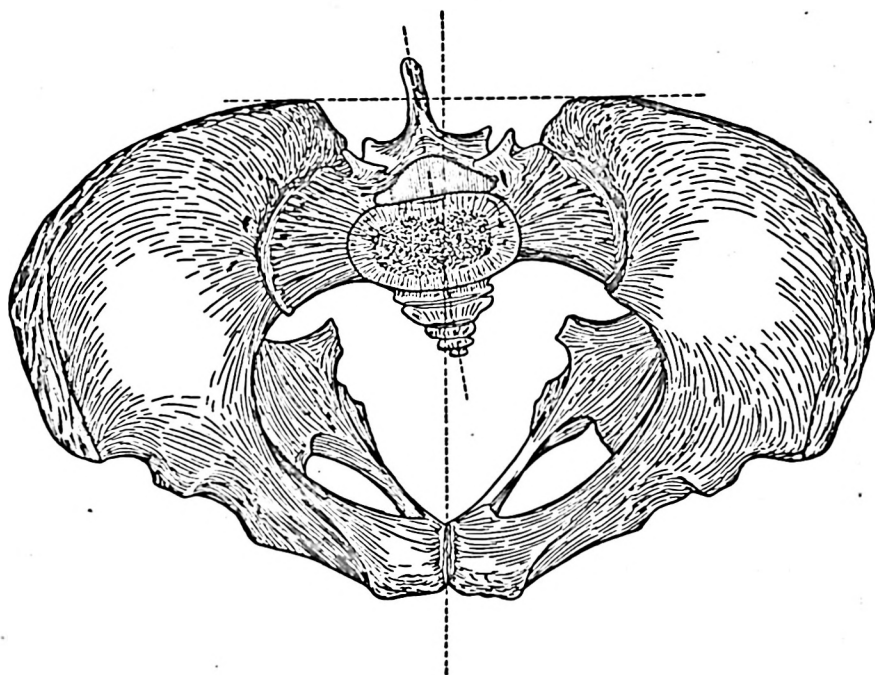


Fig. 77. Superior View of the Pelvis Showing Rotated Sacrum.

## Subluxated Ilii Tilted Pelvis

It is often difficult for the student to distinguish between a superior ilium and a tilted pelvis. Figures 78 and 79 illustrate the difference and show, in both cases, one ilium higher than the other. In Fig. 78 the left ilium is subluxated toward the superior while in Fig. 79 the pelvis is tilted with an adaptative scoliosis in the lumbar region.

In the case of the subluxated ilium shown in Fig. 78, it will be observed that the left ilium and that the posterior superior spine of the ilium is nearer the median line than the posterior superior spine of the right ilium. This shows that the left ilium is not only superior but that it is also posterior. This ilium would be listed P. S. (Posterior and Superior).

In adjusting an ilium the point of contact is usually found on a line with the rudimentary spinous process of the first segment of the sacrum as shown in the illustration. The point of contact is marked in Fig. 79 not because the ilii in this case should be adjusted but merely to show the location of the point of contact with reference to the base of the sacrum. In Fig. 78 the left ilium should be adjusted and the point of contact is clearly indicated. The dotted line indicates the normal position of the left ilium.

It must be remembered that in a case of a subluxated ilium where the superiority is great enough to make one leg shorter than the other that it will produce a Static Scoliosis

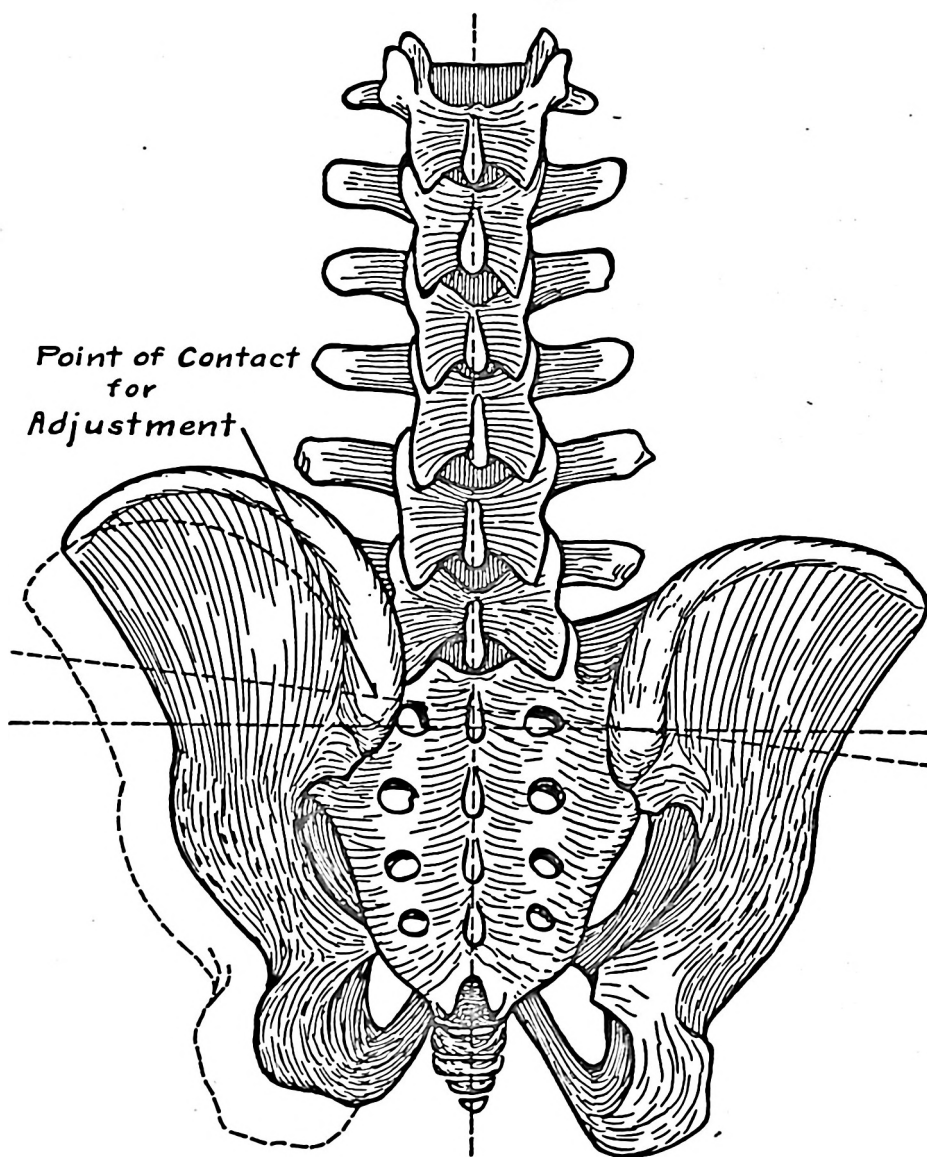


Fig. 78. Posterior View of the Pelvis and Lumbar Region Showing Subluxated Left Ilium.

In such cases this must not be confused with a tilted pelvis. In the case of a tilted pelvis the posterior superior spines of the ilii will both be the same distance from the median line of the sacrum while the rudimentary spinous processes of the sacrum will not be in a perpendicular plane.

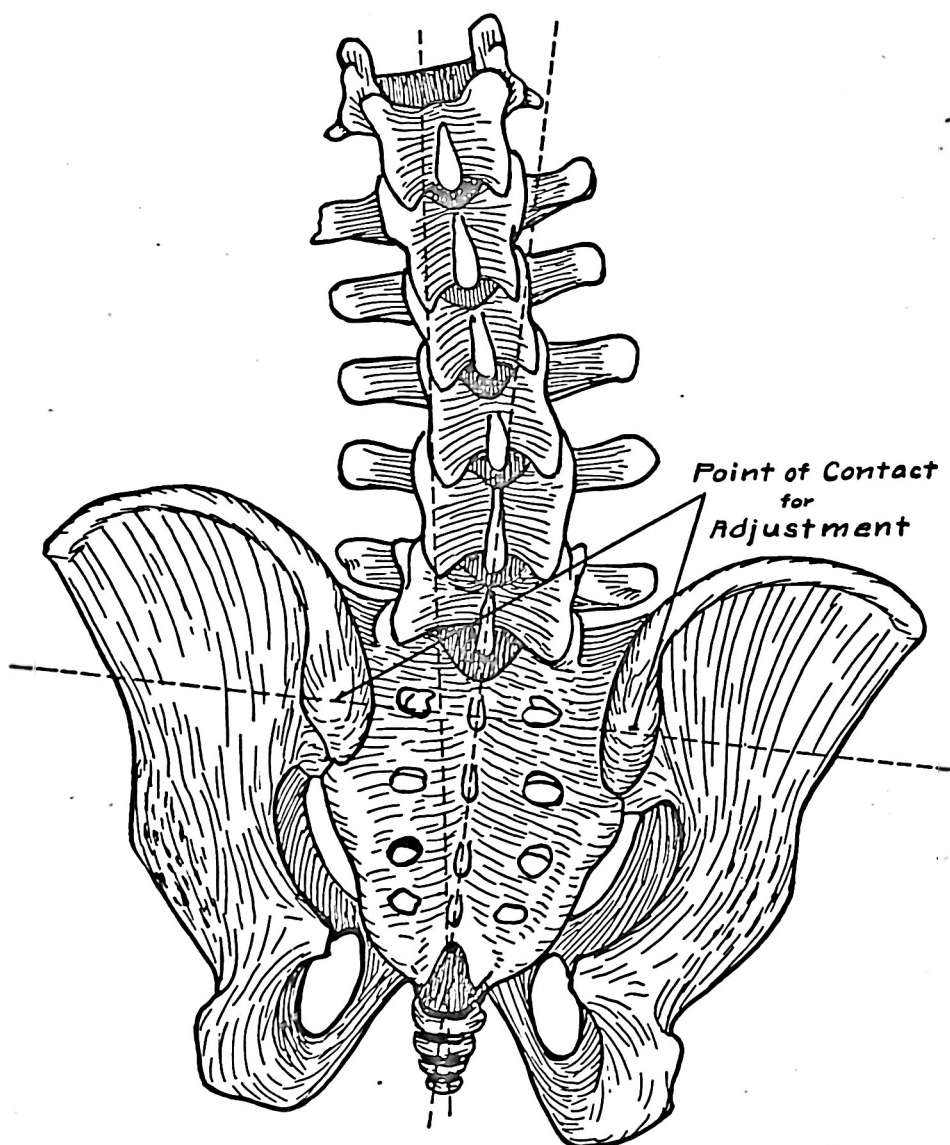


Fig. 79. Posterior View of the Pelvis and Lumbar Region Showing Tilted Pelvis with Scolosis in Lumbar Region.

**PART VII.**  
**Meric System**

## The Meric System

Chiropractically the body is divided into zones, the boundaries being governed by the distribution of the spinal nerves.

Zone means a belt or district and when applied to the earth means one of the five great belts into which the earth's surface is divided with respect to latitude and temperature. It may mean a belt or district within which certain animals or plants are found. A Zone in the body is a belt or section of the body containing certain tissues and organs.

Definition: Meric, of or pertaining to mere; mere, meaning a boundry.

A Zone is composed of one segment of the spinal column together with the pair of spinal nerves superior to that segment and all the tissues supplied with mental impulses by that pair of spinal nerves or to which that pair of nerves ramify. It can thus be seen that there can be no hard and fast lines of demarcation drawn between the several zones for they are found to overlap a great deal on this account.

When we say the zones overlap we do not mean that some tissue cells receive mental impulses from two different neuromeres but that some tissues may lie within the "geographic" bounds of tissues supplied by other nerves. To use a concrete illustration we will take the heart. The heart is in the ninth zone, that is, the principal bulk of the heart is supplied with mental impulses by the pair of nerves which emit superior to the second dorsal vertebra, but there are por-

tions of the heart that receive impulses through the eighth neuromere or the nerves that emit superior to the first dorsal. Other portions receive impulses from the tenth neuromere, the nerves that emit superior to the third dorsal. But those tissue cells which receive their nerve supply through the ninth neuromere, the pair of nerves superior to the second dorsal vertebra, do not also receive impulses through the nerves superior to the first dorsal or superior to the third dorsal. In other words, a tissue cell can not be in more than one zone, but an organ, which is made up of many tissue cells, may be in more than one zone.

As the body is divided into zones so the zones are divided into MERES. Chiropractically applied to the body, a mere is all of any one kind of tissue in a zone. We might go farther in this division and say that the tissues which constitute a zone are divided and subdivided until we have reached the anatomical unit of man which is the tissue cell.

The mere is named according to the kind of tissue under discussion. To illustrate: All the integument in a zone is known as the deramere. All of the bone tissue in a zone is known as the ossomere. There are as many meres in a zone as there are different kinds of tissue in that zone.

#### **Generic Titles of the Vertebrae.**

In the consideration of the Zonal division of the body we must also consider the Generic titles of the different segments of the spinal column. The different segments are given a title according to their location in the spine or the principal organs in that particular zone.

The word **GENERIC** means of or pertaining to genus. **GENUS** means that which has under it several species. The generic title which is given a vertebra indicates, so to speak,

the species involved in that zone, which in this case, would be the tissues or more especially the principal organs. This, however, is literally true only in the dorsal region.

It will be necessary for the student to become familiar with the generic titles of all the vertebrae in each region of the spine for we find it much more convenient to use only Chiropractic terminology. It will also be necessary for the student to learn the tissues that are found in the different zones. This is absolutely essential in order to become a first class analyst, for the analyses is the most important part of a Chiropractor's work. The tissues in a zone are determined by nerve tracing and clinical results.

The Atlas is in the first zone and constitutes the first vertemere. The generic title of the Atlas is "Atlas Place," abbreviated "At. P." The pair of nerves superior to the Atlas constitute the first neuromere. The Atlas, the first pair of spinal nerves and all the tissues to which this first pair of nerves carry mental impulses, constitutes the first interior mERIC zone. It is not necessary for us in the study of Chiropractic Orthopedy to study the anatomy of the different structures in the zones, but it is a part of Orthopedy to outline and name all the structures and tissue found in each zone. It is not for us, however, to go into detail but merely name these structures.

The first pair of spinal nerves, or sub-occipital nerves, constitute the neuromere in this first zone. The osseomere of the first zone consists of all the bone or osseous tissue and includes the eight cranial bones, the atlas and the ossicles of the ear. The viscemere of this zone includes the brain. The dermamere is the integument of the scalp, the upper ear and the upper forehead. The myomere of the first zone would take in all the muscle tissue covered by the dermamere. It

will not be a difficult matter for the student to remember these tissues if an effort is made to visualize and get the mental picture of this zone and its structures, remembering that the first zone includes the brain, the cranial bones, the scalp, the upper ear, the ossicles, the upper forehead, and the Atlas.

The Second Zone consists of the axis together with the pair of nerves superior to the axis and all the tissues supplied with mental impulses through this pair of nerves.

The axis forms the second vertemere. The second pair of nerves forms the second neuromere. The osseomere of the second zone consists of the atlas, the axis, and those parts of the osseous tissue listed in the first zone as might be supplied by the second pair of spinal nerves. The same can be said of the viscemere as is stated of the osseomere for the brain being so large it stands to reason that some of the fibers from the second pair of nerves would find their way to the tissues of the brain and if that be true then that part of the brain would be in the second zone. The dermamere of this zone would include the integument the width of a vertebra lower than that of the first zone, including part of the face, extreme upper portion of neck and the skin of the ears. The myomere would include the muscles listed in the first zone that might be supplied by this neuromere, but in addition a part of the muscles of the extreme upper part of the neck, the ears and a portion of the face. In learning the tissues of this zone the student will do well to keep in mind the fact that this zone is closely associated with the first zone and therefore they overlap, some of the cells of a structure may receive mental impulses through the first pair of nerves and other cells of the same structure may receive their mental impulses from the second pair of nerves therefore placing that structure or organ in two zones.

The Third Zone consists of the third cervical vertebrae and the pair of spinal nerves superior to the third cervical and all the tissues supplied with mental impulses through this pair of nerves. The third cervical vertebra forms the vertemere in this zone and with the fourth and the fifth cervical vertebrae is given the Generic title of Middle Cervical Place, abbreviated M. C. P.

The tissues found in this zone include the different meres, such as those of the nasal passages and the cheeks. Some of the fibers of these nerves extend up to the supraorbital region, taking in the retina. The trifacial nerve is also listed in this zone.

The Fourth zone consists of the fourth cervical vertebra, the pair of spinal nerves superior to the fourth cervical and all the tissues supplied with mental impulses by that pair of nerves. The Vertemere of this Zone is the fourth cervical vertebra. The fourth pair of nerves forms the neuromere. The fourth cervical vertebra, the fourteen bones of the face, and the hyoid bone constitute the fourth osseomere.

Fifth Zone: The fifth cervical vertebra, the pair of nerves superior and all the tissues that are supplied with mental impulses by this pair of nerves constitute the fifth inferior meric zone. The fifth cervical vertebra constitutes the fifth vertemere and together with the third and the fourth cervical is given the generic title of M. C. P. The fifth neuromere is composed of the fifth pair of spinal nerves which emit between the fourth and the fifth cervical vertebrae. This zone is found to overlap the fourth zone and involve many of the tissue cells in the structures that are contained in the fourth zone, such as, portions of the eye, nasal passages, sometimes a part of the fourteen bones of the face and the teeth. This zone lying next inferior to fourth zone would include the structures next

below, which would mean that the mandible and the hyoid bone would be included in the ossomere and that the posterior and lateral neck muscles would constitute the myomere. The deramere would include all the integument covering the myomere.

**Sixth Zone:** The sixth zone consists of the sixth cervical vertebra, the pair of nerves superior and all the tissues that are supplied with mental impulses by this pair of nerves. The sixth cervical vertebra constitutes the sixth vertimere and is given the generic title of L.C.P. The neuromere of this zone would be the sixth pair of spinal nerves. The tissues that are supplied by the sixth neuromere would include the tissues of the neck, the posterior portion of the mouth, the upper bronchii, the sterno-mastoid muscle, superior portion of the shoulders and the anterior portion of the arms extending down into the tissues of the hand. It may also include the trachea, the cervical glands and the thyroid gland.

**Seventh Zone:** This zone is found to overlap the sixth and the eighth zones and the tissues that are involved in these zones are the portion of those structures found in the sixth and eighth zones which receive their supply of mental impulses from the seventh pair of spinal nerves. The tissues listed in this particular zone are the posterior neck muscles, the upper part of the arm, the deltoid muscle, the trachea and upper portion of the bronchii.

The vertemere in this zone is the seventh cervical vertebra; the neuromere, the seventh pair of spinal nerves. The generic title is L.C.P.

**Eighth Zone:** The first dorsal vertebra which is the eight segments in the spinal column, forms the eight vertemere. The pair of nerves superior forms the eighth neuromere. The eighth zone consists of all the tissues that are supplied

with mental impulses by this neuromere. The most important meres in the dorsal region must be recognized as the vertemeres. The boundaries of these zones will vary greatly on account of the wide range of distribution of these spinal nerves and this variation is due to the fact that in this region of the body most of the vital organs are located. It is very necessary for the student to have a clear understanding of the location of the viscera and the relation of this location to the vertemere. In this brief study of the Meric system, it is not our aim to give the anatomy, but merely to mention the tissues that are supplied by the different nerve trunks. The generic title given the first dorsal vertebra is A.P. (Arm Place.)

The viscermere of the eighth zone would include the extreme superior portion of the heart, the portion of the bronchial tubes and the extreme superior portion of the lungs. The dermamere would include the integument on either side of a horizontal plane drawn through the intervertebral foramen superior to the eight vertemere, also the integument covering the posterior portion of the shoulders, the posterior portion of the arms down to and including some of the integument of the hands. The myomere might be spoken of as those muscles that are covered by the deramere, although the myomere might not be constant with the deramere, but might include muscle tissue which would extend into and overlap the meres of other zones.

The ossomere would include the clavicle, the scapula, the humerus, the ulnar, the radius, the carpals, the metacarpals and the first rib.

The Ninth Zone: The ninth vertemere would be the second dorsal vertebra. The ninth neuromere would be the ninth pair of nerves, and the ninth zone would include all the tissues supplied with mental impulses by these nerves. Heart

Place is the generic title given the second dorsal vertebra and is abbreviated H. P. The visceremere includes the heart, the pericardium, the aorta, the upper portion of the lungs and a portion of the trachea. The deremere of this zone would lie just inferior to the deramere next above. The myomere would include the muscles in this region of the back, the intercostal muscles between the first and second ribs, portions of the muscles covering the chest, those extending out over the shoulders and some of the muscles extending over the posterior surface of the arm. The ossomere would include the radius, the ulnar, the carpals, the metacarpals, and the second pair of ribs.

**The Tenth Zone:** The tenth zone consists of the third dorsal vertebra, the pair of nerves superior to this segment of the spine and all the tissues that are supplied with mental impulses by this pair of spinal nerves. The tenth vertemere consists of the third dorsal vertebra. The tenth neuromere is formed by the tenth pair of spinal nerves. The generic title given to the third dorsal vertebra Lung Place. (LU.P.) The visceremere of this zone includes the bulk of the lung tissue, the inferior portion of the heart, which would also include the covering of the heart and we find in many cases that incoördinations of the lung will respond to adjustments given on the third dorsal vertebra, which goes to show that some of the tissue cells of the liver receive their supply of impulses from fibers that emit superior to the third dorsal vertebra. We will find in consideration of the deramere of the different zones that each succeeding deramere will lie just inferior to the preceding deramere and as it is difficult to draw hard and fast lines of demarcation between the zones, we will find that to determine the exact boundaries of the deramere in any particular zone it is necessary to make a careful nerve

tracing of the same. The myomere of the tenth zone would include the muscles of the upper portion of the back and the chest, together with the intercostals, muscles between the second and third ribs. The ossomere would be the third pair of ribs, the lower portion of the sternum and in rare cases portions of the bones of the arm.

**The Eleventh Zone:** The eleventh zone is formed by the fourth dorsal vertebra, which would constitute the eleventh vertemere, the pair of nerves superior, which constitute the neuromere and all the tissues that are supplied with mental impulses by this neuromere. The liver being the principal organ in this zone, the vertebra is given the generic title of Liver Place (L.I.P.) The viscemere of this zone would include not only the liver, but also the gall bladder, bile duct, the lower portion of the lung, and in very rare cases, the extreme lower portion of the heart. The deramere of this zone would include all the integument supplied by the eleventh neuromere. The myomere would include all the muscle tissues of this zone. The ossomere of the eleventh zone would be the fourth pair of ribs.

**The Twelfth Zone:** The twelfth zone is formed by the fifth dorsal vertebra, the pair of nerves superior and all the tissues that are supplied with mental impulses by this pair of nerves. The fifth dorsal vertebra is the vertemere and the twelfth pair of nerves the neuromere. The ossimere consists of the fifth pair of ribs. This region is spoken of as the general heat mere and there are very few tissues listed in this zone. The generic title is Center Place (C.P.). All direct fevers are the result of a subluxation of this vertemere. It is found that the fifth dorsal vertebra is often liver place. This is proved by results that are obtained from adjustments at this point. We also occasionally find an inco-ordination of

the stomach as a result of pressure upon the twelfth neuromere.

The Thirteenth, Fourteenth and Fifteenth Zones: The generic title given the sixth, seventh and eighth dorsal vertebrae is Stomach Place, (S.P.), from the fact that the stomach receives its supply of impulses from the nerves emitting superior to these segments. The sixth dorsal vertebra is the thirteenth vertemere, the pair of nerves superior being the thirteenth neuromere. The seventh dorsal vertebra is the fourteenth vertemere and the pair of nerves superior form the fourteenth neuromere. The eighth dorsal vertebra is the fifteenth vertemere and the pair of nerves superior form the fifteenth neuromere. We will consider the tissues involved in these three zones altogether because the zones are so closely related and overlap to such an extent that it is almost impossible to consider one zone separately. The viscemere of these three zones would include the stomach, the esophagus, the pharynx, the vocal chords, the thyroid glands, the omentum, the uvula and the tonsils. We would also include in this zone the gums, the palate, the tongue, glands of the mouth, the eyeball, the iris, the pupil and the cornea. In the fifteenth zone will be found the pancreas, portions of the spleen, the diaphragm, and the duodenum. The dermamer in these zones would include all the integument supplied with mental impulses by nerve fibers from the thirteenth, fourteenth and fifteenth pairs of spinal nerves. The same may be said of the muscle tissues of these zones. The ossomeres of these zones would be the sixth, seventh and eighth pairs of ribs, respectively.

The Sixteenth Zone: The sixteenth zone consists of the ninth dorsal vertebra, the sixteenth pair of spinal nerves and all the tissues to which this pair of nerves carry mental im-

pulses. The ninth dorsal vertebra is the ninth vertemere, the generic title of which is Spleen Place (Spl.P.). The sixteenth pair of nerves form the sixteenth neuromere. The viscemere of this zone overlaps that of the fifteenth and seventeenth zones. The tissues involved here would be the spleen, the duodenum and the omentum. The ossomere would include the ninth pair of ribs.

The Seventeenth, Eighteenth and Nineteenth Zones: The generic title given the tenth, eleventh and twelfth dorsal vertebrae is Kidney Place (K.P.). The tenth dorsal is in the seventeenth zone and constitutes the seventeenth vertemere. The seventeenth neuromere is composed of the pair of nerves superior to the seventeenth vertemere. The tissues involved in this zone include the supra-renal capsules, the upper portion of the kidneys, the eyelids and the tenth pair of ribs. The eleventh dorsal is in the eighteenth zone and constitutes the eighteenth vertemere. The eighteenth neuromere is composed of the pair of nerves superior to the eighteenth vertemere. The tissues involved in this zone include the kidneys, the upper portion of the ureters, the eyelids, eleventh pair of ribs. The deremere of this zone would include integument supplied by mental impulses by the eleventh pair of spinal nerves. The myomere would include all the muscle tissue in this zone. The twelfth dorsal is in the nineteenth zone, and constitutes the nineteenth vertemere. The nineteenth neuromere is composed of the pair of nerves superior to the nineteenth vertemere. The tissues involved in this zone include the twelfth pair of ribs, the lower portion of the kidneys, the ureters and the end of the spinal cord. The deramere and the myomere of this zone would include all the integument and muscle tissue receiving their supply of mental impulses through the nineteenth neuromere.

**The Twentieth Zone:** The twentieth zone is formed by the first lumbar vertebra and the pair of nerves superior and all the tissues supplied with mental impulses by this pair of spinal nerves. The first lumbar vertebra is given the generic title as Upper Lumbar Place or Upper Private Place, and constitutes the twentieth vertemere. The twentieth neuromere consists of the twentieth pair of spinal nerves. The tissues involved in this zone are given as the upper portion of the small intestines, the peritoneum, the loins, and the ureters. This zone overlaps the twenty-first zone and the deramere, the myomere and the ossemere could be listed the same as those of the twenty-first zone.

**The Twenty-first Zone:** The twenty-first zone consists of the second lumbar vertebra, the pair of nerves superior and all the tissues supplied with mental impulses by this pair of spinal nerves. The second lumbar consists of the twenty-first vertemere and is given the generic title of Upper Lumbar Place or Upper Private Place. The twenty-first pair of nerves form the neuromere of this zone. The tissue supplied by this neuromere are the small intestines, the leg muscles, the vermiform appendix, the peritoneum, the ovaries and the secum.

**The Twenty-second Zone:** The twenty-second zone is formed by the third lumbar vertebra, the pair of nerves superior and all the tissues supplied with mental impulses by that pair of spinal nerves. The third lumbar is given the generic title of Middle Lumbar Place or Private Place and constitutes the twenty-second vertemere. The twenty-second pair of spinal nerves form the twenty-second vertemere. The organs involved in this zone include the sexual organs, the bladder, lower small intestines, the caecum, the colon, the abdominal muscles, the anterior thigh muscles, vermiform appendix, and the knee.

**The Twenty-Third Zone:** The twenty-third zone is formed by the fourth lumbar vertebra, the pair of nerves superior and all the tissues supplied with mental impulses by that pair of nerves. The fourth lumbar is given the generic title of Lower Lumbar or Lower Private Place and constitutes the twenty-third vertemere. The twenty-third pair of spinal nerves form the twenty-third vertemere. This one overlaps the twenty-second to such an extent that the tissue listed in the twenty-second zone might also fall in the twenty-third zone, but the twenty-third zone also includes the large intestines, the hip bones, the legs and the feet.

**The Twenty-fourth Zone:** The twenty-fourth zone is formed by the fifth lumbar vertebra, the pair of nerves superior and all the tissues supplied with mental impulses by that pair of spinal nerves. The fifth lumbar is given the generic title of Lower Lumbar Place or Lower Private Place, and constitutes the twenty-fourth vertemere. This zone blends with the twenty-third. The main tissues in this zone are portions of the rectum and the bowels, the vagina, the prostate gland, the bladder, and the posterior part of the thighs. Extending downward, this zone includes the posterior portion of the limbs.

PART VIII.

Arthrology  
Syndesmology

## Arthrology

The study of the articulations of the body is divided into two parts:

- (a) Arthrology, which is known as the study of joints.
- (b) Syndesmology, which is known as the study of ligaments.

A joint is a union between bones, or it may be a union between a bone and a cartilage, in which there is limited or free motion. The degree of motion depends upon the connecting media. When the two opposing elements are directly united it forms an immovable joint. Some joints are temporary, that is, the parts later become fused. Other joints are permanent; they remain movable under normal conditions. Some are called joints, not because of the fact that there is motion between the parts, but because of the manner in which the parts were developed.

The structures found in a joint will vary with the character of the joint and will depend upon whether there is to be free or limited motion. In every joint there will always be found two opposing elements, bones or cartilages, or both. Besides these the other tissues involved are synovial membrane, ligaments, muscles, nerves and blood vessels.

Joints are classified as follows:

**Synarthroses**—The immovable joints.

**Amphiarthroses**—The partly movable joints.

**Diarthroses**—the freely movable joints.

The **Synarthroses** are subdivided as follows:

1. **Sutures**—These have no cartilage and no synovial membrane; the surface of the bones come in direct contact. In this kind of joint there is no appreciable motion. Sutures are classed as True and False.

(a) True sutures are those where the opposing connected bone surfaces are tooth-like, saw-like, or bevelled.

(b) False sutures are those where the bones of the joint overlap, or are in direct apposition.

2. **Schindylesis**—A joint formed by a plate of bone entering into a fissure of another bone.

3. **Gomphosis**—A joint formed by a conical process of bone fitting into a socket.

4. **Synchondrosis**—A joint formed by a strip of hyaline cartilage between the two opposing bones. This cartilage ultimately ossifies and destroys all possibility of motion.

The **Amphiarthroses** are subdivided as follows:

1. **Symphysis**—A joint in which there is a fibro-cartilage between the two opposing bones, but no synovial membrane.

2. **Syndesmosis**—A joint in which the two opposing elements are united by an interosseus ligament.

The **Diarthroses** are subdivided as follows:

1. **Ginglymus**—A hinged joint where there is motion in two directions only and that is forward and backward.

2. **Trochoid**—A pivot joint which is formed by a ring formed around a pivot.

3. **Condylloid**—A joint in which a condyle or oval head fits into an elliptical cavity.

4. **Reciprocal Reception**—Or saddle joint, is one which is formed by a surface inversely convex or concave.

5. Enarthroses—Or ball-and-socket joint, is a joint in which a large globular head fits into a deep cavity.

6. Arthrodia—Or gliding joints, are formed by flat articulating surfaces which glide over each other.

The classification of the different joints and examples of each can be outlined as follows:

#### I. Synarthroses:

##### (a) Sutures—

True—Inter-frontal suture.

False—Inter-maxillary suture.

##### (b) Schindylesis—

Articulation of the sphenoid with the vomer.

##### (c) Gomphosis—

Articulation of the teeth in the alveoli.

##### (d) Synchondrosis—

Articulation between the segments of the sacrum.

#### II. Amphiarthroses—

##### (a) Symphysis—

Articulation between the bodies of the vertebrae; also between the apex of the sacrum and the base of the coccyx.

##### (b) Syndesmosis—

The radio-ulnar articulation.

#### III. Diarthroses:

##### (a) Ginglymus—

The articulation of the heads of the ribs with the bodies of the vertebrae.

##### (b) Trochoid—

The articulation between the atlas and the odontoid process.

- (c) Condylod—  
The occipito-atlantal articulation.
- (d) Reciprocal Reception—  
The carpo-metacarpal joint of the thumb.
- (e) Enarthrosis—  
The hip joint.
- (f) Arthrodia—
  1. The articulations between the vertebral arches.
  2. The articulation between the ribs and the transverse processes of the vertebrae.

In the study of Orthopedy we are particularly concerned with the kind of joints that are found in the spinal column. In the following outline the classification of the joint is first given, then the joints of the spine, if any, that are found in that classification.

#### Synarthrosis.

Sutures—There are no sutures in the spinal column.

Synchondrosis—The joints between the segments of the sacrum and also those between the segments of the coccyx belong to the synchondrosis class. This is because these segments are separated in early life by plates of hyalin cartilage, which, later in life, ossifies and obliterates the plane of the articulation between the segments so that direct structural continuity takes place.

The Sacro-iliac articulation is classed as a synchondrosis joint, but this is not a correct classification since no such union takes place between the sacrum and the ilii, under normal condition. This is proved by the fact that the sacrum may be moved as well as the ilii by Chiropractic adjustments.

**Amphiarthroses.**

**Symphysis**—The articulation between the bodies of the vertebrae is classed as a symphysis joint. In this kind of articulation the opposing structures are connected by fibro-cartilage and as the discs between the bodies of the vertebrae are composed of white fibro-cartilage these joints remain movable during life. The sacro-coccygeal articulation also belongs to this classification.

**Syndesmosis**—There are no articulations of this subdivision of the Amphiarthrosis classification in the spinal column.

**Diarthroses.**

**Ginglymus**—The articulation of the heads of the ribs with the bodies of the vertebrae forms a ginglymus joint, since the motion is motion in two directions only.

**Trochoid**—The articulation between the atlas and the axis around the odontoid process is a good example of a true trochoid joint. In this articulation the motion is that of rotation around the pivot which is formed by the odontoid process.

**Condyloid**—The only typical condyloid articulation in the spine is that between the condyles of the occipital bone and the superior articulations of the atlas. There is also some gliding motion between the occipit and the atlas.

**Reciprocal reception**—There are none of this class of joints in the spinal column.

**Enarthrosis**—There are no true ball-and-socket joints in the spinal column. although the movements between the bodies of the vertebrae are, in a limited sense, of this type of joint. These joints are not, however, enarthrodial in mechanism for there is no globular head fitting into a deep concavity,

as is necessary in order to have a true joint of this classification, but it may be classed as a ball-and-socket joint in function from the fact that there is some motion in all directions.

**Arthrodia**—Of the *Diarthroses* classification, the *Arthrodial* type predominates in the spine. The articulations between the vertebral arches are all *arthrodial* joints. There is also some gliding motion in the articulation between the condyle of the occipital bone and the superior articulating surfaces of the atlas. The articulation between the inferior articulating surfaces of the atlas and the superior articulating surfaces of the axis also form an *arthrodial* joint.

The articulations of the spinal column are divided as follows:

**Vertebral articulations:**

Between the bodies of the vertebrae—*Symphysis*, also *enarthrosis*.

Between the vertebral arches—*Arthrodial*.

**Occipito-atlantal articulation:**

Between the occipit and the atlas—*Arthrodial*.

**Occipito-axial articulation:**

Between the occipital bone and the axis by means of ligaments only.

**Atlanto-axial articulation:**

Between the atlas and the axis—*Trochoid*, also *Arthrodial*.

**Lumbo-sacral articulation:**

Between the fifth lumbar vertebra and the base of the sacrum—*Symphysis*, and, also, *Enarthrodial*.

**Sacro-coccygeal articulation:**

Between the apex of the sacrum and the base of the coccyx—*Symphysis* and also *Enarthrosis*.

**Costo-vertebral articulations:****Costo-central.**

Between the heads of the ribs and the bodies of the vertebrae—Ginglymus.

**Costo-transverse.**

Between the tubercle of the rib and the transverse process of the vertebrae—Arthrodial diarthrosis.

**Ilio-lumbar articulations:**

Between the ilii and the lumbar vertebrae by ligaments only.

**Sacro-iliac articulations:**

Between the sacrum and the ilii—Amphiarthrodial.

## Syndesmology

Syndesmology is the study of ligaments. It is closely associated with Arthrology and considered in connection with this subject for ligaments plays a very important part in the articulation.

Webster's definition of a ligament is:—"A tough band of tissue serving to connect the articular extremities of bones or to support or retain an organ in place. Most ligaments connecting bones are composed of coarse bundles of very dense, white, fibrous tissue placed parallel to one another, or closely interlaced. They are pliant and flexible, but inextensible, so as to hold the parts in proper relation." The Ligamenta Subflava and the Ligamenta Nuchae are exceptions and are composed of yellow elastic tissue.

### Ligaments of the Spine (Spinal ligaments).

The nine ligaments of the spine are divided into three groups with three ligaments in each group. There are three ligaments attached to the bodies, three ligaments attached to the spinous processes and three ligaments attached to the descriptive parts. The following outline will help the student in the study of the ligaments of the spine. In this outline the ligaments are grouped according to the parts to which they are attached.

#### Group Number I. Fig. 80.

Ligaments attached to the bodies:

1. Anterior Common Ligament.
2. Posterior Common Ligament.
3. Intervertebral Discs.

**Group Number II. Figs 80-85.**

Ligaments attached to the spinous processes:

1. Supra Spinous Ligament.
2. Inter Spinous Ligaments.
3. Ligamentum Nuchea.

**Group Number III.**

Miscellaneous Ligaments: Figs. 80, 84, 87.

1. Inter Transverse Ligament.
2. Ligamentum Subflava.
3. Capsular Ligaments.

**Group Number One:**

**The Anterior Common Ligament. Figs. 80, 87.**

The Anterior Common Ligament of the spine is a long flat ligamentous band extending from the body of the axis to the base of the sacrum. It passes over the anterior surfaces of the bodies of the vertebrae. It is attached to the anterior surfaces of the intervertebral discs, and to the contiguous margins of the bodies of the vertebrae, but not to the transverse concavity of the anterior surfaces of the bodies.

The fibers of this ligament vary in length; the first layer consists of short fibers, the shortest of which are attached to the contiguous margins of two adjacent vertebrae. Others extend from the margin of one vertebrae to the margin of the second vertebra below, and thus the fibers continue to get longer as we reach the outer layer.

The Anterior Common Ligament gradually becomes wider from above downward and extends transversely from one vertebral root around the anterior surface of the body to the vertebral root of the other side ensheathing the entire surface of the spine.

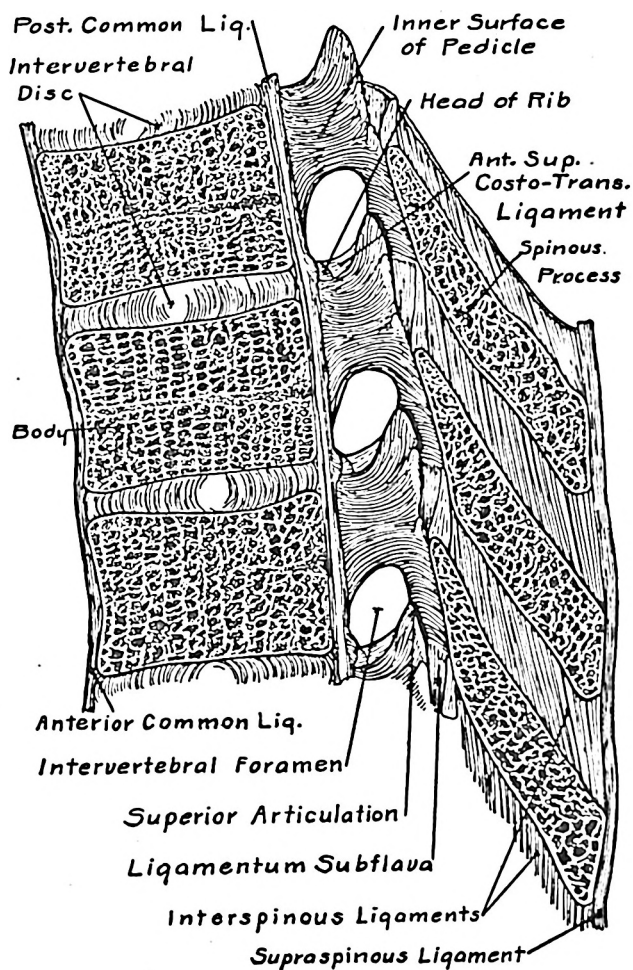


Fig. 80. Median Section Through Three Dorsal Vertebrae Showing Spinal Ligaments.

**The Posterior Common Ligament. Figs. 80, 86.**

The Posterior Common Ligament consists of longitudinal fibers which extend from the posterior surface of the body of the axis to the base of the sacrum passing down over the posterior surface of the vertebrae and of the intervertebral discs. It is situated inside of the vertebral canal forming a ligamentuous lining of the anterior wall.

In the cervical region it is uniform in width, but in the dorsal and lumbar regions it is not so wide, just opposite each vertebral body the fibers spread in a series of denate projection on both sides to the upper lateral surfaces of each body just superior to the pedicles.

**The Intervertebral Discs. Figs. 80, 81.**

The Intervertebral Cartilages are twenty-three lenticular discs of white fibre cartilage which are firmly attached to the bodies of the vertebrae. They vary in size and shape in different regions of the spine and correspond in size and shape to the horizontal surfaces of the bodies of the vertebrae to which they are attached. The centers of the intervertebral discs consist of an incompressible fluid pulp which gives it great flexibility and elasticity. The discs are also thickened in the center, hence they are spoken of as being lenticular. In the cervical and lumbar regions they are thicker at the posterior than at the anterior.

According to different authors the intervertebral discs form from one-fifth to one-fourth the length of the spine. The sum of the thickness of the discs is greatest through the center, less at the anterior, while at the posterior the sum of the thickness of all the discs is just a little more than half that of the center of the discs.



*Intervertebral Disc (dried)  
with Epiphyseal Plates attached*

Fig. 81.

The above illustration is not a specimen from a human spine, but is from the spine of a young elk. It shows how the epiphyseal plates can be separated from the body of the vertebra. It also shows the intervertebral disc very nicely. This specimen was picked up in Yellowstone Park by the author.

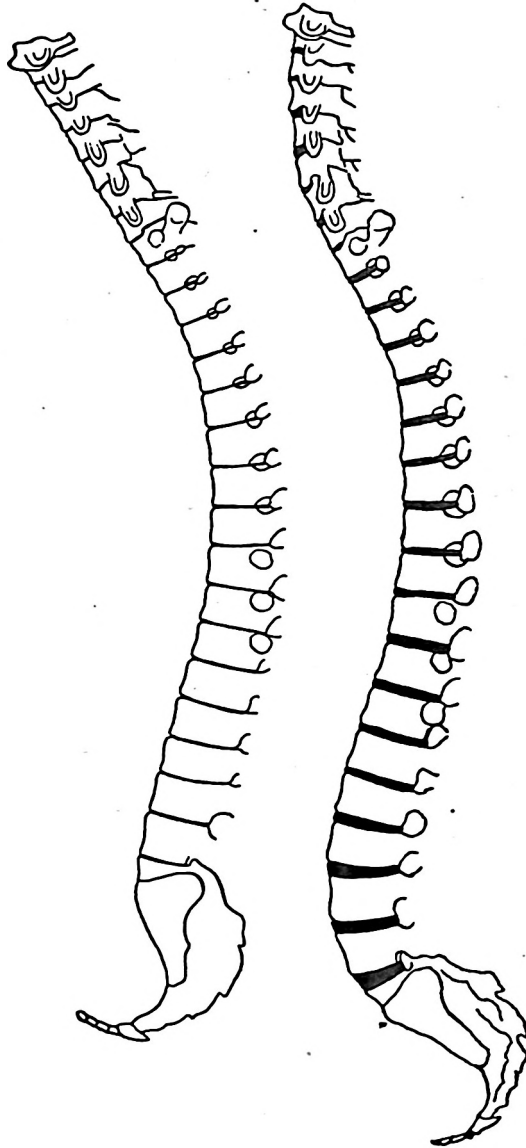


Fig. 82. Spine Without the Intervertebral Discs.  
Fig. 83. Spine With the Intervertebral Discs.

The intervertebral discs assist in the formation of the curves of the spine. If the bodies of the vertebrae are separated from the pedicles and placed one above another to form a column they will form one continuous posterior curve extending from the body of the axis to the body of the fifth lumbar, as shown in the illustration. This shows that the primary curve is formed by the shape of the bodies of the vertebrae. In adult life the erect posture, with the weight all at the anterior of the supporting shaft, necessitates the production of adaptative curves and the intervertebral discs are so changed as to produce two adaptative curves and the spine assumes the shape shown in illustration No. 82. In old age the intervertebral discs gradually change this shape until, instead of being wedge-shape, they become flattened like a washer or a flat layer of cartilage. This gives the characteristic stooped posture of old age.

The intervertebral discs in the cervical region become thinner at the posterior than at the anterior producing an anterior curve in this region. A similar change takes place in the lumbar region, but to a greater extent producing a more exaggerated anterior curve in this region.

The anterior common and the posterior common ligaments are firmly attached to the intervertebral discs. Each intervertebral disc helps to form the anterior wall of the intervertebral foramen and also assists in the formation of the facets for the articulation of the heads of the ribs in the dorsal region from the second to the ninth inclusive. While the discs attach the bodies of the vertebrae firmly together they also separate the bodies from each other and form a joint with a limited amount of motion and absorb a great deal of the shock produced in walking. They act as shock absorbers or buffers.

The function of the intervertebral discs may be summed up as follows:

1. They attach the bodies together firmly.
2. They separate the bodies from each other.
3. They act as powerful ligaments.
4. They give shape to the spine by forming the adaptative curves.
5. They act as buffers absorbing the shocks and jars.
6. They help to form the intervertebral foramina.

#### Group Number Two.

Supra Spinous Ligament.

Interspinous Ligament.

Ligamentum Nuchae.

#### Supra Spinous Ligament. Fig. 80.

The Supra Spinous Ligament is a ligamentous cord of longitudinal fibers which extends from the spinous process of the seventh cervical vertebrae downward over the tips of the spinous processes of the vertebrae to the rudimentary spinous process of the first segment of the sacrum. The fibers are of varying lengths extending from one spinous process to another. They are attached firmly to the tips of the spinous processes of the dorsal and lumbar vertebrae. In some cases this ligament may be developed to such an extent that difficulty may be experienced in palpating the vertebrae. This ligament assists in holding the vertebrae in their proper place and limits the lateral rotation of the segments.

#### The Interspinous Ligament. Fig. 80.

The Interspinous Ligament consists of a series of ligaments, each of which is found between two adjacent spinous

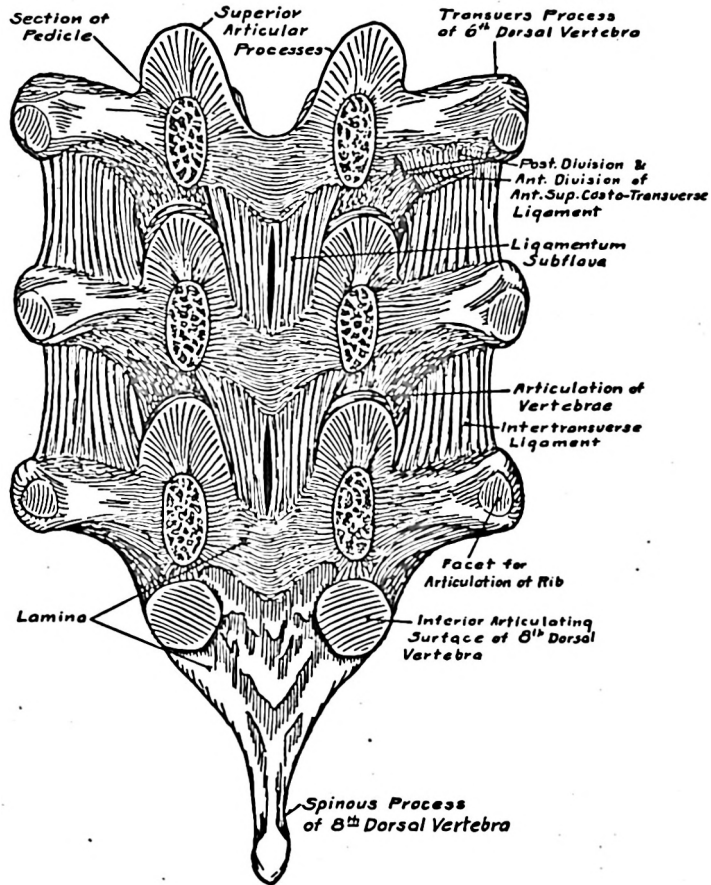


Fig. 84. Three Dorsal Vertebrae With the Pedicles Sectioned and the Bodies Removed, Showing the Anterior Surface of the Laminae and the Ligaments.

processes. The fibers are oblique and pass from the inferior margin of the spinous process above to the superior margin of the spinous process below. The length of the fibers are equal to the distance between the spinous processes, while the width of the ligament is equal to the distance from the tip of the spinous process to the root of the spinous process. These ligaments are in apposition with the supra spinous ligament at the posterior and the ligamenta subflava at the anterior.

**Ligamentum Nuchae. Fig. 85.**

The Ligamenta Nuchae contains a small proportion of yellow elastic fibers and is a continuation upward of the supraspinous ligament. It extends from the tip of the spinous process of the seventh cervical vertebra up to the external occipital protuberance. Its superior attachment is to the external occipital crest from the posterior border of the foramen magnum up to the external occipital protuberance; it is attached to the tips of the spinous processes of all the cervical vertebrae, including the posterior tubercle of the atlas, by means of an aponeurosis.

In man this ligament is not highly developed, but in some of the lower animals, and especially those with a long neck, it is very highly developed and composed of yellow elastic fibers which give great assistance to the muscles of the neck in supporting the weight of the head.

**Group Number Three.**

Ligamenta Subflava.

Intertransverse Ligaments.

Capsular Ligaments.

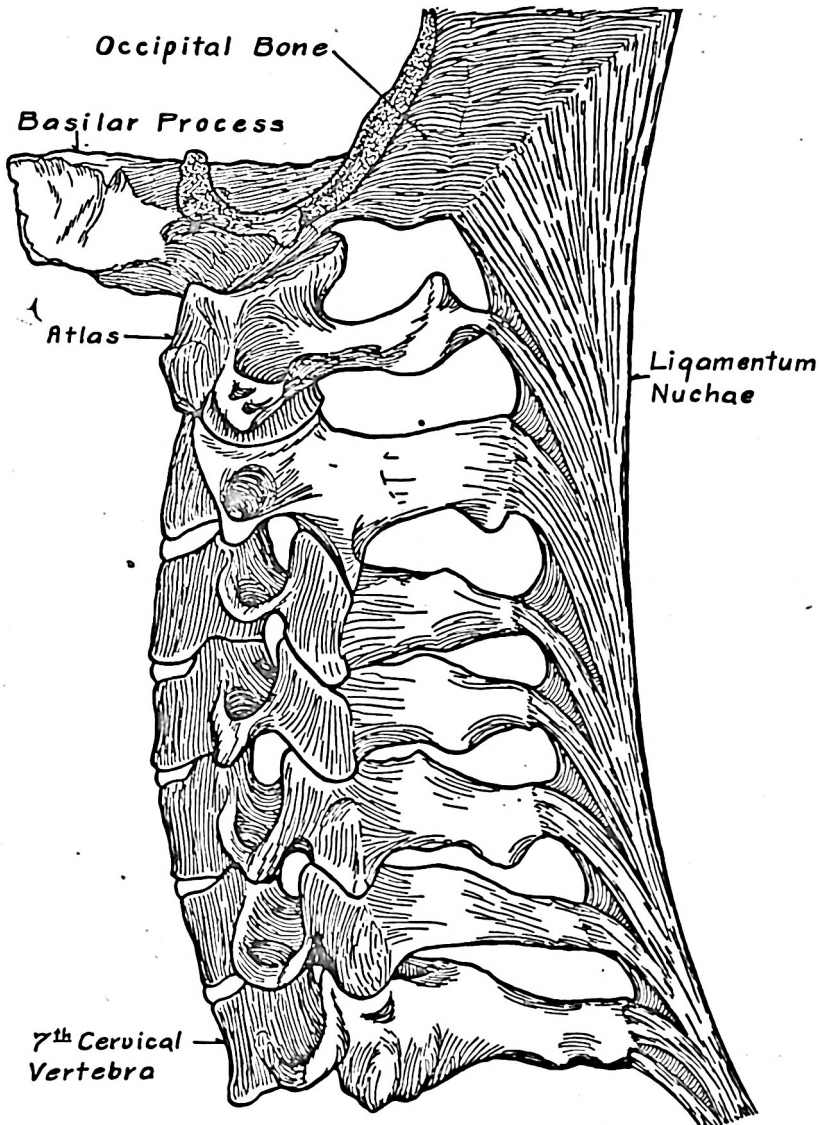


Fig. 85. Cervical Region Showing the Ligamentum Nuchæ.

**Ligamenta Subflava. Figs. 80, 84.**

The Ligamenta Subflava is composed of yellow elastic fibers and is found between the laminae of the vertebrae. In the thoracic region where the imbrication of the laminae is pronounced these ligaments are scarcely visible from the posterior, but they are plainly visible from the posterior in the cervical and the lumbar regions. Each ligament is attached to the anterior margin of the inferior surface of the laminae above and to the superior surface of the laminae below; some of the fibers extend out between the laminae to the posterior surface. These ligaments complete the vertebral canal at the posterior between the laminae.

The fibers of the ligamenta subflava are divided medially so that there is in reality two separate ligaments to the laminae of each vertebrae. They extend laterally to the capsular ligaments on either side, and are inseparably attached to them. The principal function of these ligaments is to limit the spine in side movements and rotation.

**Intertransverse Ligament. Fig. 84.**

The Intertransverse Ligaments consist of a collection of short vertical fibers between the transverse processes. They are attached superiorly to the inferior surface of the transverse process of the vertbrae above and to the superior surface of the transverse process of the vertebrae below. The fibers of these ligaments are short, being equal to the distance between the transverse processes.

**Capsular Ligaments. Fig. 87.**

The articular processes are formed at the junction of the pedicles with the laminae and when the articulating surfaces are in proper apposition with those of the adjacent vertebrae

they form a true diarthroses of the arthrodial variety. Surrounding these articulations are loose ligamentous sacs called capsular ligaments. They form a capsule which encases the articulation and contains the synovial membrane. There is a capsular ligament for each pair of adjacent articulating processes. The capsular ligament arises from the periosteum near the border of the articular cartilage.

Illustration No. 87 is a pen drawing of a specimen in the P.S.C. Osteological Studio. It shows the anterior portion of the occipital bone and the cervical region down to the fifth cervical vertebrae. Upon these parts we have placed the ligaments which are found in this region. Some of the ligaments are shown as cut and laid back in order to show other ligaments which lie beneath. By placing as many ligaments as possible on the same drawing, we are enabled to give the student a better understanding of the relation of these ligaments. The posterior arch of the atlas is cut away just posterior to the intervertebral grooves. The laminae of the axis, the third cervical and the fourth cervical vertebrae are cut away just posterior to the articular processes.

The anterior margin of the Foramen Magnum is clearly seen. It gives the student a good idea of the attachment of the Middle Odontoid Ligament, as well as the other ligaments that are attached in this region.

The Check Ligaments or Lateral Odontoid Ligaments can be seen attached to the sides of the apex of the odontoid process, which, in the illustration, is represented by a dotted line.

The Occipito-Axial Ligament is shown attached to the inner side of the Foramen Magnum, but these fibers are cut and laid back for the purpose of revealing the other ligaments

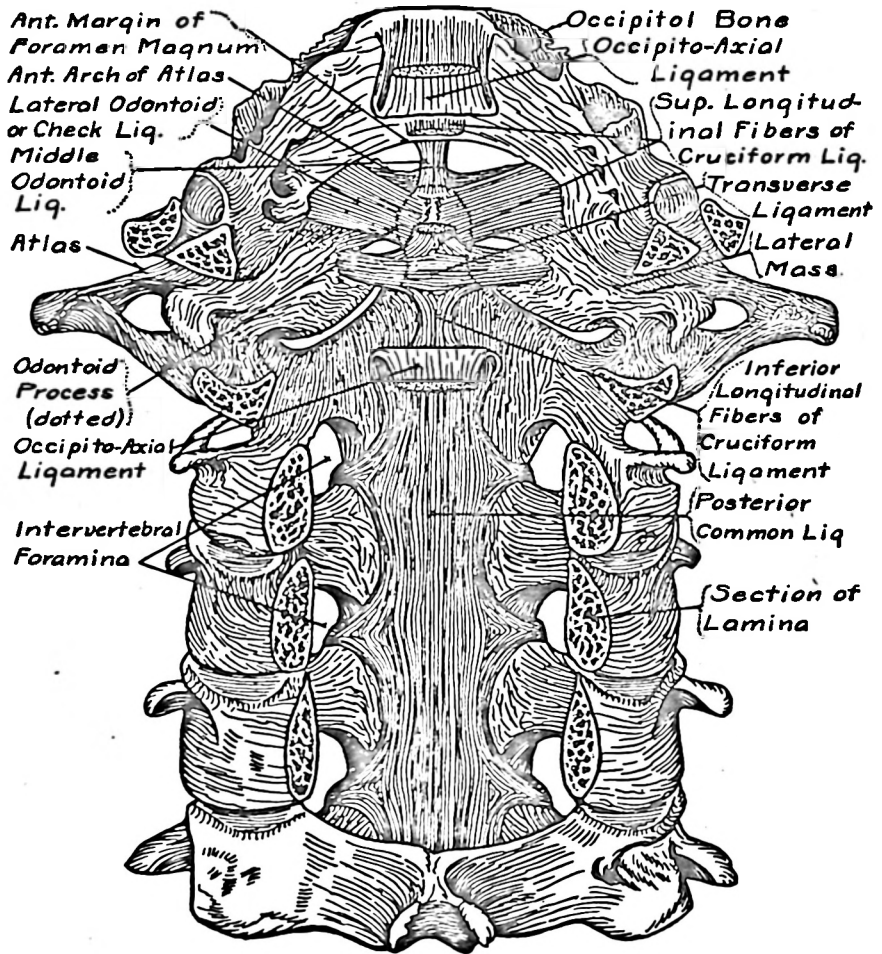


Fig. 86. Cervical Region With Portion of the Vertebral Arches Removed Showing Posterior Surface of Bodies and the Ligaments.

that are covered by this one as it passes upward from the posterior surface of the body of the axis.

The Transverse Ligament of the atlas is shown attached to the lateral masses of the atlas stretching across the odontoid process. There is also shown the superior and the inferior radiating fibers which form the Cruciform Ligament. The fibers of the Cruciform Ligament that pass upward from the Transverse Ligament are also shown attached above. These fibers are shown as cut and laid back in order to show the middle Odontoid Ligament.

The Posterior Common Ligament is clearly shown on the posterior surface of the bodies of the vertebrae from the body of the axis to that of the fifth cervical vertebrae.

The transverse processes of the atlas can be clearly seen. Those of the axis are not so plainly visible while the transverse processes of the remaining vertebrae can barely be seen. A portion of the posterior surface of the pedicles are visible and the intervertebral foramina can be clearly seen from the posterior.

### Ligaments of the Occipito-Atlantal Articulation

- The articulation between the Occipital bone and the Atlas is called the Occipito-Atlantal articulation. There are two articulations; one on the right side and one on the left, between the superior articulating surfaces on the atlas and the condyles of the occipital bone. Each is a diarthrosis and forms a condyloid joint. There is some gliding motion which would place it in the arthrodial class of joints. It might also be classed as ginglymous joint as it has some motion as a hinge joint.

These ligaments are arranged somewhat different from

the nine ligaments of the spine. They are named, for the most part, according to the parts to which they are attached.

Following are the ligaments of the Occipito-Atlantal Articulation:

1. Anterior Occipito-Atlantal Ligament.
2. Posterior Occipito-Atlantal Ligament.
3. Lateral Occipito-Atlantal Ligaments.
4. Capsular Ligaments.

Fig. 87.

The Anterior Occipito-Atlantal Ligament, or *Membrana Atlanto-Occipitalis Anterior*, is a flat, strong, membranous band extending between the occipital bone and the posterior arch of the atlas. It is attached above to the anterior margin of the foramen magnum and below to the posterior superior surface of the anterior arch of the atlas. It fills in the small space between the atlas and the occipit and completes the neural canal at the anterior. Between the anterior tubercle of the atlas and the basilar part of the occipital bone it is developed into a large bundle of fibers that is sometimes called Accessory Occipito-Atlantal Ligament.

Fig. 86.

The Posterior Occipito-Atlantal Ligament, or *Membrana Atlanto-Occipitalis Posterior*, is a broad, flat and well developed membranous band of fibers which extends from the posterior margin of the foramen magnum above where it is attached, to the posterior superior surface of the posterior arch of the atlas below, where it is firmly attached. It completes the neural canal at the posterior between the atlas and the occipital bone. It is attached inferiorly to the posterior superior surface of the posterior arch of the atlas up to the grooves

just posterior to the lateral masses. Here, instead of the ligament being attached to the floor of the groove, it stretches across to the posterior margin of the superior articular process of the atlas and forms the groove into a foramen for the exit of the first pair of spinal nerves. It is not uncommon to find these fibers ossified and as a result the foramen becomes a permanent bony foramen. Laterally this ligament is continuous with the Capsular ligaments.

**Fig. 87.**

The Lateral Occipito-Atlantal Ligaments are attached to the transverse processes of the atlas and to the jugular process of the occipital bone. They are small and unimportant.

The Capsular Ligaments are two loose, ligamentous sacs which are attached to the contiguous margins of the superior articular processes of the atlas and the margins of the condyles of the occipit. There are two of these ligaments, one for each articulation. They entirely surround the articulation and contain the synovial membrane.

In addition to the above named ligaments there is the Ligamentum Nuchae, which is attached to the tubercle on the posterior arch of the atlas and to the external occipital protuberance on the occipital bone. As this ligament is described with the nine ligaments of the spine, we will not describe it here.

### Occipito-Axial Ligaments

**Fig. 86.**

The articulation between the Occipital bone and the Axis is a diarthrodial joint; it is not a direct articulation, but is accomplished by means of the ligaments that are attached to the occipital bone and the axis. In some cases the odontoid

process of the axis is found to be of such length that it articulates directly with the occipital bone, but this is rare. When this condition does exist there will be found a capsular ligament and synovial membrane in the articulation just the same as any other joint. The ligaments involved in this articulation are the following:

1. Occipito-Axial Ligament.
2. Lateral Odontoid, or Check Ligaments.
3. Middle Odontoid, or Ligamentum Suspensorium.

The Occipito-Axial Ligament is attached to the anterior superior surface of the body of the axis and to the basilar groove of the basilar process of the occipital bone. It covers the posterior surface of the odontoid process and its ligaments. It lies inside of the neural canal, forming the ligamentous lining for the anterior wall and is a continuation upward of the posterior common ligament. This ligament is also called the *Membrana Tectoria*.

The Lateral Odontoid, or Check Ligaments, also called the Alar Ligaments, are two strong, rounded bands of fibers that are attached to the rounded surface on each side of the summit of the odontoid process or dens and extend upward laterally and are attached above to the tubercles on the condyles of the occipital bone. Their function is to check or limit the rotation of the head. Some of the fibers pass from one condyle to the other and are not attached to the odontoid process, but these are merely fibers that are not important as compared to the ligament itself. In some cases, according to Piersol, these fibers may be collected into a distinct, round, glistening bundle.

The space between the odontoid process and the basilar process of the occipital bone is filled in with dense fibrous tissue which extends to the Occipito-Atlantal Ligament.

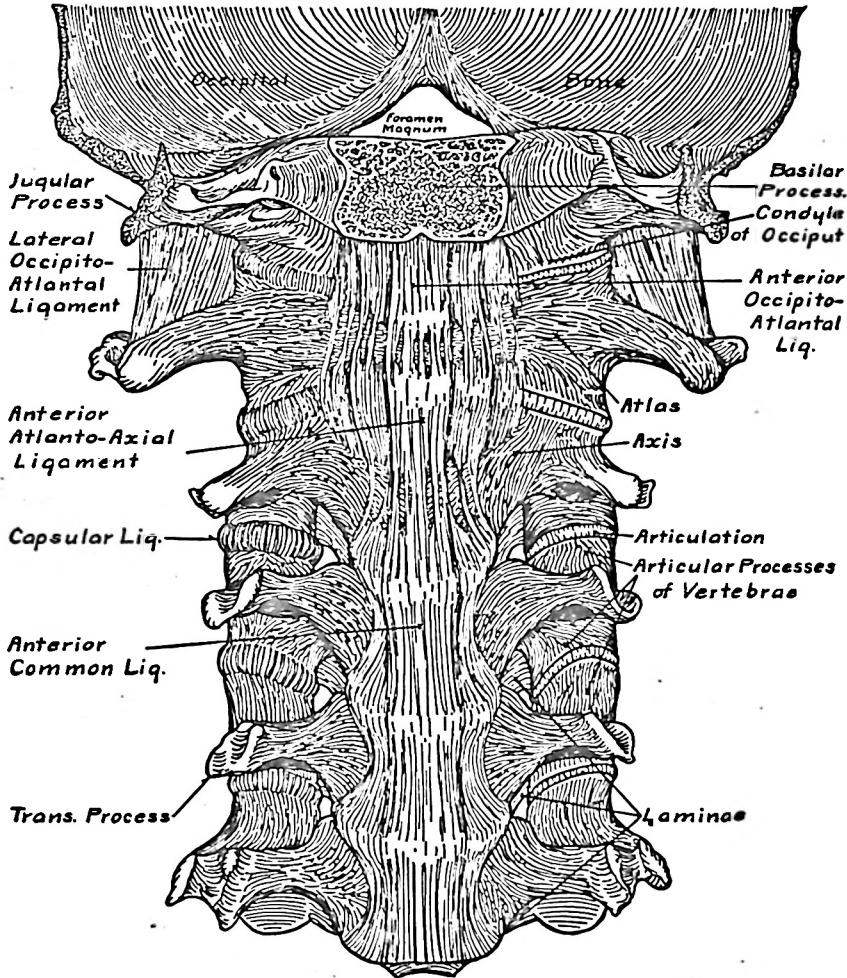


Fig. 87. Anterior View of Cervical Region Showing the Ligaments.

The Middle Odontoid Ligament, or Ligamentum Suspensorium, also called Ligamentum Apicis Dentis, is attached to the apex of the Odontoid process and above to the anterior margin of the foramen magnum. Cunningham states that this ligament, to some extent, represents the intervertebral fibro cartilages between the bodies of the other vertebrae. The middle odontoid ligament forms a round ligamentous band of fibers extending upward through the mass of ligamentous fibers which fills in the space between the odontoid process and the occipit.

### Atlanto-Axial Ligaments

Figs. 86, 87.

The articulation of the atlas with the axis is called the Atlanto-Axial articulation. It is a diarthrodial joint and placed in the sub-classes of arthrodial and pivot joints. The movement of this joint as a pivot is around the odontoid process, the pivot of the rotation being the odontoid. The head rotates with the atlas around this pivot. The degree of rotation is limited by the check ligaments. This articulation is also classed as an arthrodial joint since there is a gliding movement between the superior articulating surfaces of the axis and the inferior articulating surface of the atlas.

1. Anterior Atlanto-Axial Ligament.
2. Posterior Atlanto-Axial Ligament.
3. Transverse Ligament of the Atlas.
4. Capsular Ligaments.

The Anterior Atlanto-Axial Ligament is a broad, flat membranous band which is attached to the anterior surface of the anterior arch of the atlas and to the anterior superior surface of the body of the axis at the base of the odontoid

process. It is sometimes called *Ligamentum Obturatorium Atlanto-epistrophica Anterior*. It is merely a continuation upward of the Anterior Common Ligament. In the center of this ligament is a rounded, raised bundle of fibers which some Anatomists call the Accessory Occipito-atlantal ligament. It passes from the occipit downward and is attached to the anterior tubercle on the anterior arch of the atlas and on down to the body of the axis, where it becomes continuous with the anterior common ligament.

The Posterior Atlanto-Axial Ligament, or *Ligamentum Obturatorium Atlanto-epistrophica Posterior* extends from the posterior surface of the posterior arch of the atlas to the posterior superior surface of the laminae of the axis. This ligament is analagous to the *ligamentum subflava* in the balance of the spine, since it occupies the space which elsewhere in the spine is occupied by the *subflava*. But this analogy is in position only, for this ligament is non-elastic while the *ligamentum subflava* is elastic.

Fig. 86.

The Transverse Ligament of the atlas is a strong ligamentous band of fibers which stretches across the ring of the atlas and is attached at either end to the little tubercles that are found on the inner sides of the lateral masses of the atlas.

This ligament divides the ring of the atlas into two unequal parts. The anterior part which receives the odontoid process is the smaller of the two. The posterior part transmits the spinal cord with its coverings. The transverse ligament of the atlas is not attached to the axis but it arches around the odontoid process at the posterior and holds it in form contact with the fovea dentalis on the posterior surface of the anterior arch of the atlas. There is a synovial mem-

brane between the transverse ligament and the odontoid process. This is in the form of a synovial sac and is larger than the one between the odontoid process and the fovea dentalis.

Extending upward from the center of the transverse ligament is a band of fibers which is attached to the basilar process and another band of fibers extend from the center of the transverse ligament downward to the anterior surface of the body of the axis, forming what is known as the **Cruciform Ligament**, or **Cross like ligament**. It is also called the **Ligamentum Cruciatum Atlantis**.

The **Capsular Ligaments** are thin, loose ligamentous sacs which surround the articulations. They are attached to the rough non-articular margins of the articular processes between the atlas and axis. Each capsular ligament is lined with synovial membrane which secretes the synovia, or joint oil.

In addition to the above mentioned ligaments there are the two **Inter Transverse Ligaments** and the **Ligamentum Nuchae** which have already been described with the nine ligaments of the spine. The **Inter Transverse ligaments** are attached to the inferior surface of the transverse processes of the atlas and to the superior surface of the transverse processes of the axis. The **Ligamentum Nuchae** is attached to the tubercle on the posterior arch of the atlas and to the spinous process of the axis.

## Costo-Vertebral Articulations

The articulations between the dorsal vertebrae and the ribs is called the costo-vertebral articulations. They are divided into two divisions:

Costo-central articulation. Fig. 88.

Costo-transverse articulation. Fig. 89.

The Costo-Central articulation consists of twelve ginglymus joints between the heads of the ribs and the bodies of the vertebrae. The head of the first rib articulates with the body of the first dorsal only. From the second dorsal to the ninth dorsal, inclusive, the head of each rib articulates with the bodies of two vertebrae and the intervening intervertebral disc. The head of the tenth rib articulates with the body of the tenth dorsal only. The head of the eleventh rib articulates with the body of the eleventh dorsal only and the head of the twelfth rib articulates with the body of the twelfth dorsal vertebrae only.

Three ligaments are attached to the heads of the ribs and the bodies of the vertebrae. These are called the Costo-Central Ligaments or the ligaments of the Costo-Central articulation. They are as follows:

- (a) Stellate Ligament.
- (b) Inter-articular Ligament.
- (c) Capsular Ligament.

The Stellate Ligament is attached to the anterior surface of the head of the rib and is then separated into three separate bundles of fibers. The superior bundle of fibers is attached to

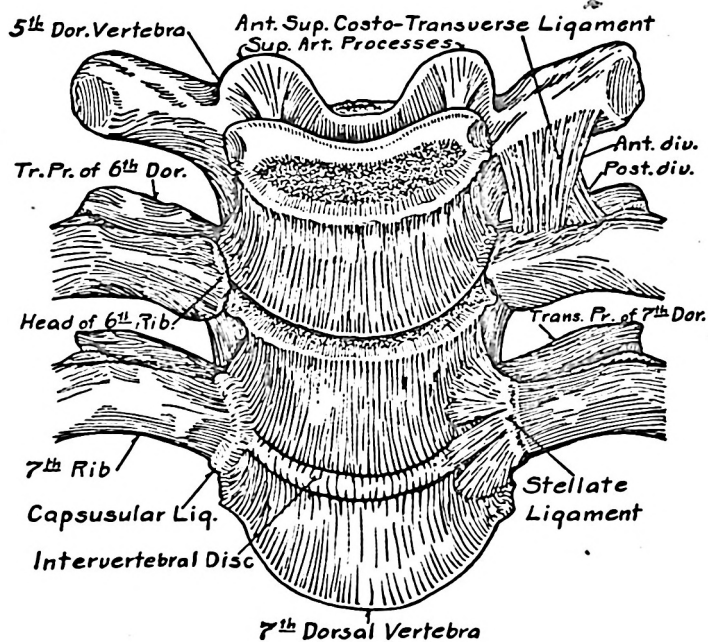


Fig. 88. Anterior View of Three Dorsal Vertebrae and the Ribs, Showing the Ligaments.

the lateral aspect of the body of the vertebra next above. The inferior bundle of fibers is attached to the lateral aspect of the body of the vertebra below while the middle bundle is attached to the intervening intervertebral disc.

The separation of fibers takes place only where the head of the rib articulates with the bodies of two vertebrae, but where the head of the rib is attached to only one body there is only one bundle of fibers. Fibers will be found extending to the body of the vertebrae above and also to the one below, but these are merely radiating fibers and are not contained in bundles. Therefore the Stellate ligament attached to the first, tenth, eleventh, and twelfth ribs are not divided into three bundles of fibers, neither are they attached to the intervertebral discs.

The Inter-Articular Ligament is a short stout ligament which is found inside of the articulation and is attached to the crest on the head of the rib and to the intervening intervertebral disc. It divides the articulation into two separate divisions, an upper and a lower. Between these two divisions there is no communication. Each division has its own synovial membrane. As this ligament is attached to the disc, it is found only where there is an intervertebral disc involved in the articulation. These articulations, therefore, have only one synovial membrane. During foetal life the inter-articular ligament extends from the head of one rib to the head of the corresponding rib on the opposite side of the spine passing across the back of the discs.

The Capsular ligaments are loose ligamentous sacs which surround the articulations. They are attached to the margins of the head of the rib and to the margin of the articulating surface on the bodies of the vertebrae. The Capsular liga-

ments entirely surround the articulation, and contain the synovial membrane.

### **The Costo-transverse Articulations.**

The Costo-transverse articulations are ten arthrodial diarthroses formed between the transverse processes of the first ten dorsal vertebrae and the tubercles of the first ten ribs. Following are the ligaments:

- I. Anterior-superior costo transverse ligaments:
- II. Middle costo-transverse ligament.
- III. Posterior costo-transverse ligament.
- IV. Capsular ligament.
- V. Lumba-costal ligament.

The Anterior-superior Costo transverse ligament is attached to the crest on the anterior superior margin of the neck of the rib. They are composed of very strong bands of fibers which pass upward and slightly outward and are attached above to the inferior surface of the transverse process next above. Those attached to the first pair of ribs and the transverse processes of the seventh cervical vertebra are not very well developed. Those attached to the eleventh and twelfth pairs of ribs are rudimentary or entirely absent.

The Middle Costo-transverse ligament consists of short strong fibers which are found between the neck of the rib and the adjacent transverse process. It is attached to the posterior surface of the neck of the rib and to the anterior surface of the transverse process with which the tubercle of the rib articulates. It is an inter-osseous ligament, the length of which is equal to the space between the neck of the rib and the transverse process while the width is equal to the length of the neck of the rib. With the eleventh and twelfth ribs this ligament is rudimentary.

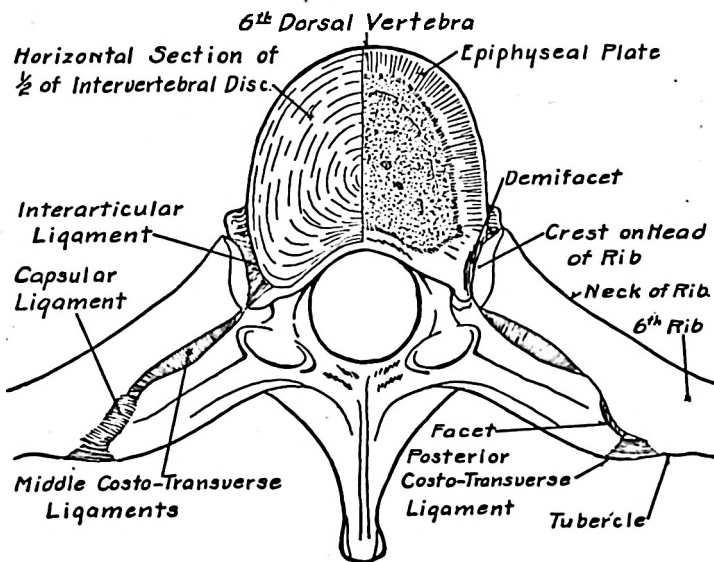


Fig. 89. Superior View of a Dorsal Vertebra and the Pair of Ribs, Showing the Ligaments.

The Posterior Costo-transverse ligament is a strong band of fibers which is attached to the rough non-articulating surface on the tubercle of the rib and to the apex of the adjacent transverse process. This ligament is not present with the eleventh and the twelfth ribs since these ribs do not articulate with the transverse processes of the vertebrae.

The Capsular ligament is a loose ligamentous sac which is attached to the margin of the articular tubercle on the neck of the rib and the contiguous margin around the articulating surface on the transverse process. It surrounds the articulation and contains the synovial membrane.

The Lumbo-Costal ligament is a small band of fibers attached to the base of the transverse process of the first lumbar vertebra. It extends upward and is attached to the inferior surface of the neck of the twelfth rib. The following outline will be found helpful.

Costo-Vertebral Articulations having two sets of ligaments:

1. Costo-Central Ligaments.
  - (a) Stellate Ligament.
  - (b) Inter-articular Ligament.
  - (c) Capsular Ligament.
2. Costo-Transverse Ligaments.
  - (a) Anterior Superior Costo-Transverse Ligament.
  - (b) Middle Costo-Transverse Ligament.
  - (c) Posterior Costo-Transverse Ligament.
  - (d) Lumbo-Costo Ligaments.
  - (e) Capsular Ligament.

The following exceptions will be noted in the attachment of these ligaments:

1. The articulation of the heads of the first, tenth, eleventh and twelfth ribs with the bodies of the corresponding

vertebrae have no inter-articular ligaments since the heads of these ribs do not articulate with the intervertebral discs.

2. The Stellate ligament is attached to the first, tenth, eleventh, and twelfth ribs, is not divided into three bundles of fibers but is attached to the bodies of the corresponding vertebrae as one bundle.

3. The Middle Costo-Transverse ligament is rudimentary or entirely absent in the eleventh and the twelfth ribs.

4. The Posterior Costo-Transverse ligament is wanting in the eleventh and twelfth ribs since these ribs do not articulate with the transverse processes of the eleventh and twelfth dorsal vertebrae.

### Lumbo Sacral Articulation

Fig. 90.

The Lumbo Sacral articulation is the articulation between the fifth lumbar vertebra and the base of the sacrum. This consists of a symphysis joint between the body of the fifth lumbar vertebra and the base of the sacrum, and an enarthrodial joint between the articular surface of the fifth lumbar vertebra which articulates with the body of the first segment of the sacrum by means of the intervertebral disc. This articulation is the same as the articulation between the bodies of the other vertebrae. There are also other ligaments between the fifth lumbar and the other parts of the base of the sacrum, the same as in the other regions of the spine.

The Anterior Common Ligament is attached to the anterior surface of the body of the fifth lumbar vertebra. The Anterior Common Ligament, the Posterior Common Ligament, the Ligamentum Subflava, the Supra Spinous,

the Interspinous Ligaments and the Capsular Ligaments are all attached here the same as in the other regions of the spine but in addition there is the Lumbo Sacral Ligament which is a well developed ligament attached to the transverse process of the fifth lumbar vertebra and the alae of the base of the sacrum. This ligament is analogous to the Inter-Transverse Ligaments in the other regions of the spine.

**Ilio-Lumbar Ligament.—Fig. 90, 91.**

The articulation between the lumbar region and the ilii is by means of a ligament which is called the Ilio-Lumbar Ligament. This ligament is attached to the anterior surface and the apex of the transverse process of the fifth lumbar vertebra and to the superior border of the crest of the ilium. This ligament is somewhat triangular in shape and is composed of a band of strong fibers.

### **Sacro-Sciatic Ligaments**

**Figs. 90, 91.**

**Great Sacro-Sciatic Ligament.**

The articulation between the sacrum and the ischium is by means of the Sacro-sciatic ligaments. The Great Sacro-sciatic ligament or sacro-tuberous ligament is a triangular ligament found between the sacrum and the innominate bones. It extends from the posterior inferior spine of the ilium across to the lateral posterior edge of the third, fourth and fifth segments of the sacrum and the first segment of the coccyx. This gives it a very broad superior attachment. The ligament becomes narrower as it proceeds downward, forward and laterally but it broadens out when

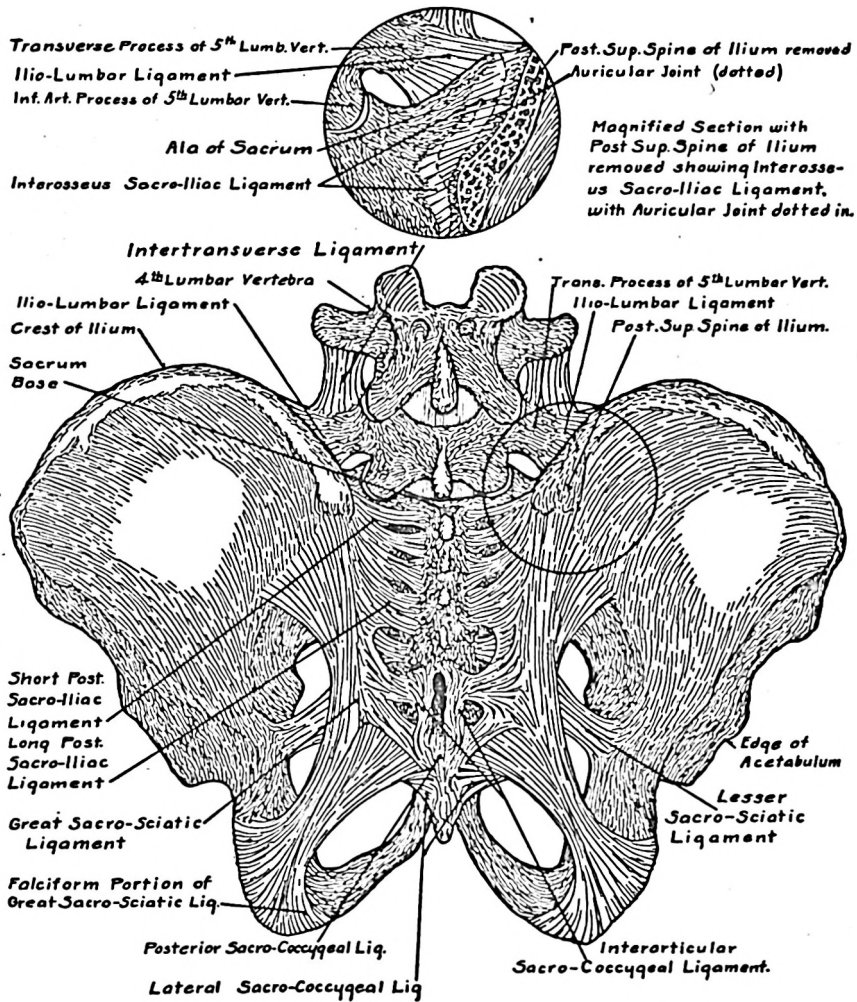


Fig. 90. Posterior View of the Pelvis Showing the Ligaments.

it nears its inferior attachment, the tuberosity of the ischium.

#### **Lesser Sacro-Sciatic Ligament.**

This ligament is also called the Sacro-spinous and the Anterior Sacro-sciatic ligament. It is much smaller than the Great Sacro-sciatic and is situated directly beneath it. The sacral attachment of this ligament is to the lateral posterior margin of the fourth and fifth segments of the sacrum and the first and second segments of the coccyx. It passes transversely across and is attached to the spine of the ischium. The sacral attachment is very much broader than the attachment to the ischium which makes the ligament triangular in shape.

The Great Sacro-sciatic and the Lesser Sacro-sciatic ligaments convert the Greater and the Lesser Sciatic notches into the Greater and the Lesser Sacro-sciatic Foramina.

### **Sacro-Coccygeal Ligaments**

**Figs 90, 91.**

The articulation between the apex of the sacrum and the base of the coccyx is similar to the articulation between the bodies of the true vertebrae.

Anterior Sacro-Coccygeal Ligament.

Posterior Sacro-Coccygeal Ligament.

Lateral Sacro-Coccygeal Ligament.

Interarticular Ligament.

Intervertebral Disc.

The Anterior Sacro-Coccygeal Ligament is a continuation downward of the anterior common ligament and is at-

tached to the anterior surface of the apex of the sacrum and the anterior surface of the base of the coccyx.

The Posterior Sacro-Coccygeal Ligament is a continuation downward of the posterior common ligament and is attached to the posterior surface of the apex of the sacrum and the posterior surface of the base of the coccyx.

The Lateral Sacro-Coccygeal Ligament is analogous to the intertransverse ligaments between the transverse processes of the true vertebrae. These ligaments are attached to the rudimentary transverse processes of the coccyx and on either side of the lateral angle of the apex of the sacrum.

The Interarticular Ligament consists of strong fibers which are attached above to the cornu of the apex of the sacrum and below to the cornu of the base of the coccyx.

The Intervertebral disc between the inferior surface of the last segment of the sacrum and the superior surface of the body of the first segment of the coccyx is identically the same as the intervertebral discs between the bodies of the true vertebrae.

### Sacro-Iliac Articulation

Figs. 90, 91.

The articulation between the sacrum and the ilii form an amphiarthrodial joint between the auricular articulating surfaces on the lateral sides of the superior two-thirds of the sacrum and the articulating surfaces on the medial side of the ilii. The ligaments are:

Anterior Sacro-Iliac.

Posterior Sacro-Iliac.

Interosseous Sacro-Iliac.

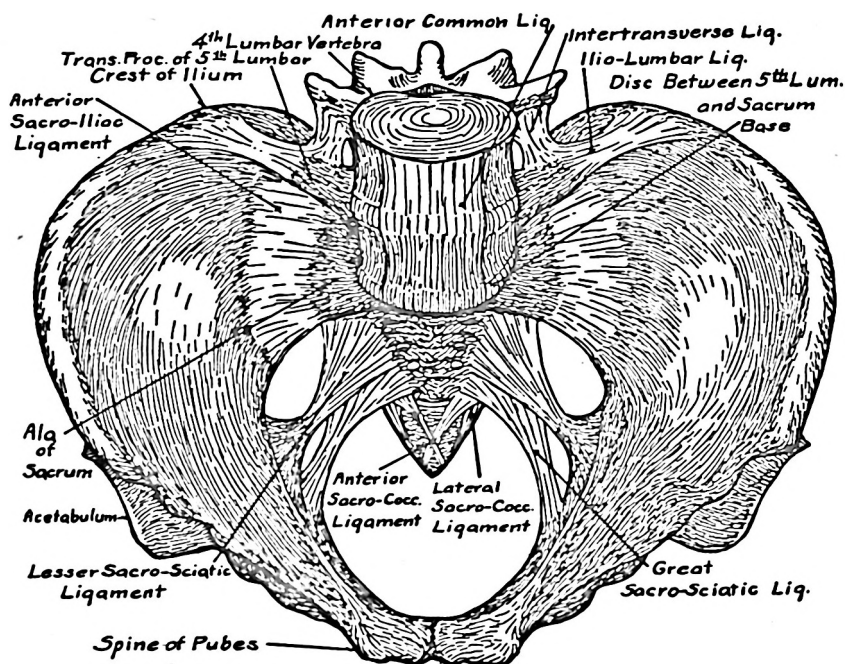
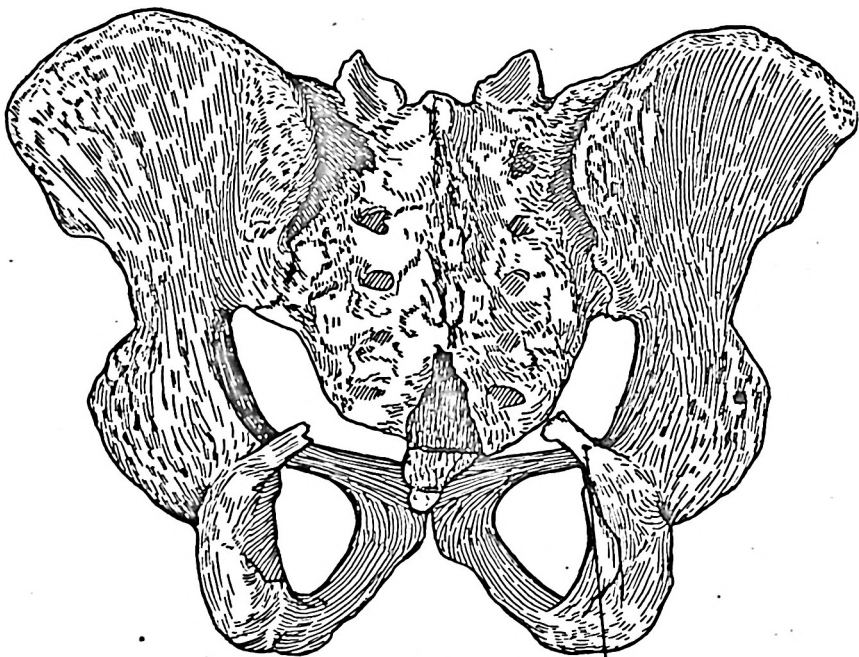


Fig. 91. Anterior View of Pelvis, 5th and 4th Lumbar Vertebrae, Showing the Ligaments.

The Anterior Sacro-Iliac ligament is formed of a thin band of fibers which are attached to the anterior surface of the alae of the sacrum near the sacro-iliac joint and to the anterior surface of the ilium. These fibers, though thin, are very strong.

The Posterior Sacro-Iliac ligament is a very powerful ligament composed of several layers of strong fibers which are attached to the posterior surface of the ilium just back of the auricular articular surfaces and to the lateral masses of the upper four segments of the sacrum. The attachment extends toward the median line almost to the posterior sacral foramina. That part of the ligament which is attached to the third and fourth segments of the sacrum is called by some anatomists the Long Posterior Sacro-Iliac Ligament. While that part which is attached to the first two segments is called the Short Sacro-Iliac Ligament. This ligament fills the deep groove between the overhanging surface of the ilium and the posterior surface of the sacrum. These powerful ligaments assist in holding the sacrum in place and prevent the base from becoming subluxated toward the anterior.

The Interosseous Sacro-Iliac ligament is a very strong ligament attached by many fasciculae to the rough medial aspect of the ilium, just superior and slightly posterior to the auricular articulating surfaces and to the rudimentary transverse processes and to the depressions lateral to them on the posterior surface of the first and second segments of the sacrum. The major portion of the weight of the trunk is suspended from the ilii by these two powerful ligaments.



*Ankylosed Sacrum & Ilii  
showing ossified ligaments*

**PART IX.**

**Movements of the Spine**

## Movements of the Spine

The spine is not an extremely flexible structure. The actual mobility is found to be very limited when movement between segments is considered but taken as a whole, the spine is capable of some movement in a great variety of directions. As a matter of fact the spinal column may be moved in practically any direction. The joint between the bodies of the vertebrae which is in reality a ball and socket joint will, by reason of the elasticity of the inter-vertebral disc, allow motion in any plane or direction between the bodies. Because of this elasticity there is also a certain amount of elasticity made possible between the segments. These motions are limited by the tension of the ligaments and the muscles or by the union of bony parts.

It is surprising to note how many movements of the spine are due to the accessory movements between the spine and the pelvis and the spine and the head. The movements of the spine may be classified as follows: (a) Flexion, (b) Extension, (c) Lateral-bending, (d) Rotation, (e) A compound movement.

Flexion is a forward bending of the spine. For the purpose of determining the flexibility of the spine, flexion is best accomplished by having the patient sit with his knees crossed and bending the body as far forward and downward as possible. However for palpating purposes the feet must both be kept squarely on the floor. The advantage of flexion of the spine is that the spinous processes of the vertebrae are

made more prominent and therefore more easily palpated in some cases, while in other cases it is a disadvantage for the supraspinous ligament may be stretched so rigidly over the spinous processes making the back feel so smooth that it makes it almost impossible to feel the vertebrae. The length of the spine in extreme flexion when measured down over the tips of the spinous processes is somewhat increased.

The lumbar region is affected more in this movement of the spine than the other regions. In some cases this flexion of the spine may almost obliterate the anterior curve.

The posterior curve in the dorsal region is exaggerated in extreme flexion, the spinous processes being thrown farther apart are made more prominent. The difference in the attachment of the ribs accounts for this. The transverse processes of the upper ten dorsal vertebrae are attached to the tubercles of the ribs and each vertebra is attached to two ribs while the transverse processes of the eleventh dorsal and the twelfth dorsal vertebrae are not attached to the tubercles of the ribs. Neither the eleventh rib nor the twelfth rib is attached to more than one vertebrae.

In flexion of the spine in the cervical region, the head is bent forward and downward to the limit of motion. This serves to obliterate the anterior curve and spread the spinous processes farther apart, making them more prominent. In extreme flexion the anterior lips on the bodies of the cervical vertebrae are forced downward into the depression in the anterior border of the superior surface of the body of the vertebra next below.

#### **Hyperextension.**

The backward bending of the spine is called Backward Flexion or Hyperextension. When the body is bent back-

ward, the greatest movement is in the lumbar and the cervical regions. The dorsal region is not affected except that the posterior curve is straightened very slightly.

It is very obvious why this movement is not evenly distributed along the entire spine when the mechanism of the spine is taken into consideration. The ribs are attached to the dorsal vertebrae and because of the imbrication of the laminae and also the spinous processes the backward movement is greatly limited while the cervical and lumbar regions are free from such and a greater mobility is obtained. The mamillary processes do not interfere with hyperextension but make this movement easier.

#### **Lateral Flexion.**

In lateral flexion, or bending of the spine toward the side, that part of the spine in which the greatest movement takes place depends upon whether the lateral flexion takes place with the patient in the erect position, or with the spine in flexion or hyperextension, or whether the patient is lying on the face or prone. In any position the greatest degree of lateral movement will be found to take place in the cervical region.

In the extreme flexed position the lateral bending of the spine is greater in the dorsal region than in the lumbar region, there being very little flexion in the latter. When the spine is bent forward the bodies are thrown closer together and the spinous processes are spread apart. This spreads the superior and inferior articular processes farther apart and makes the interlocking between the mamillary processes closer, thus interfering with the lateral bending. In the dorsal region there are no mamillary processes, the articulating surfaces are flat and the attachment of the ribs is such as to limit, but not

prevent, the lateral movement entirely. But it must be remembered that in this lateral flexion there is always a rotation of the vertebrae that are involved. Since the greatest lateral bending occurs in the dorsal region, the greatest rotation would also be found in this region. The bodies of the vertebrae are rotated toward the convexity of the lateral curve. In other words with a bending of the trunk toward the right, the bodies of the dorsal vertebrae would be rotated toward the left.

With the patient in the erect position the lateral flexion takes place largely at the K. P. region, that is, the lower dorsal and the upper lumbar vertebrae. Although the entire lumbar region enters into the bending, the upper dorsal region is very slightly affected. The bodies are rotated toward the concave side of the lateral curve.

In hyperextension of the spine with lateral flexion, the bending takes place almost entirely in the lumbar region. In hyperextension the dorsal region is not involved to any great extent. The rotation takes place in the lumbar region; the bodies are rotated toward the convexity of the lateral curve.

In the lateral bending of the spine in the flexed position the dorsal region is affected most. In the erect position, the greatest lateral movement is in the lower dorsal and upper lumbar region, while in hyperextension the lateral movement is almost entirely confined to the lumbar region. In a lateral bending of the spine in the flexed position the bodies of the dorsal vertebrae are rotated in the direction of the convexity of the lateral curve. In the erect position and the hyperextended position the bodies are rotated toward the concavity of the lateral curve in the lateral bending of the spine.

The change which takes place in the lateral bending of the spine is of little importance to the Chiropractor, when

the patient is lying on the bench ready for adjustment. With the patient lying on his back there is no chance to palpate him, so the only time this would be of importance would be in taking a spinograph and when this is done the patient must lie perfectly straight upon the table.

### **Rotation.**

Rotation is a twisting of the spine. As has already been shown this takes place to a certain degree in every case of lateral bending. The greatest possibility of rotation is in the cervical region.

It is possible to get greatest rotation in the cervical region, as all movement is freest in this region. The next greatest rotation is in the dorsal region. In the lumbar region this movement is least. But this varies; it depends upon flexion or hyperextension of the spine.

In the flexed position the rotation is more marked in the upper dorsal and the cervical regions, there being very little if any rotation in the lower dorsal and the lumbar regions. The forward bending of the spine locks the lumbar segments against rotating forces.

In the hyperextended position of the spine the rotations practically all take place in the lower dorsal and the upper lumbar regions usually involving the eleventh and the twelfth dorsal vertebrae and the first and the second lumbar vertebrae. The middle and the upper dorsal regions are only slightly affected.

### **Rotation in the Erect Position.**

In the erect position the rotation is freest in the cervical and dorsal regions, while the lumbar region is practically unaffected except when exaggerated rotating force is applied.

Rotation is by far the freest of the dorsal movements but this decreases from above downward.

With all rotating movements of the spine there is also more or less lateral bending of the spine in the opposite direction from that in which the trunk is rotated. If the bodies are rotated toward the right the convexity of the curve will be toward the left.

The movements in the different regions of the spine then would be summed up as follows:

#### Cervical Region.

**Flexion.** In this region, the greater part of the flexion is the result of the movement between the atlas and the occiput, or in the Occipito-Atlantal articulation, although the anterior curve may be entirely straightened out by forced flexion.

**Hyperextension.** The anterior curve is greatly exaggerated. In forward bending of this region the distance from the external occipital protuberance to the seventh cervical, when measured over the tips of the spinous processes, is greatly increased. In backward bending this distance is greatly decreased.

**Lateral.** In this movement the bodies of the vertebrae are rotated toward the convexity of the lateral curve the same as in the lumbar region.

**Rotation.** When the cervical region is rotated in either direction it will be found that the greater part of the rotation takes place between the atlas and the axis around the odontoid process. The rotation at this point is freer than at any other point on the spine. In rotation the cervical region is bent in such a way as to produce a curve with the convexity in the opposite direction in which the head is turned. If the head is rotated toward the left the curve will be toward the right,

while the bodies are rotated toward the left. If the head is turned toward the right the convexity of the curve will be toward the left with the rotation of the bodies of the vertebrae involved toward the right.

### Dorsal Region.

The natural curve in the dorsal region is a posterior curve, that is, a natural bending of the spine with the convexity toward the posterior. There is less mobility in this region of the spine than in any of the other regions for the vertebrae are very firmly held in position by the attachment of the ribs.

Flexion of this region slightly exaggerates the posterior curve but not to any great extent. The bodies are thrown closer together and the spinous processes are separated.

In Hyperextension of the spine the dorsal region is affected very little. This is because of the imbrication of the spinous processes and the laminae. The greatest movement in this region is at the eleventh and the twelfth dorsal vertebrae.

When Lateral Bending is applied to the dorsal region it will be found that the entire region is about evenly affected with possibly a little greater movement in the middle dorsal region. This movement is greatest when the individual is in the erect position; it is less in the flexed position but in the hyperextended position there will be very little lateral bending possible. The reason for this is obvious. The bodies of the vertebrae are always rotated in the opposite direction from that of the lateral bending. If the lateral bending is to the right the convex side of the curve will be toward the left and the bodies of the vertebrae will be rotated toward the left.

Rotation takes place in the dorsal region more frequently than in any other region of the spine, the upper dorsal being most susceptible to this form of movement. In fact, the dorsal region is more susceptible to Rotation than to any other movement. Rotation takes place more readily in the erect position, less in the flexed position and least in the hyperextended position. In forced hyperextension it is claimed there is no rotation at all in the dorsal region.

In rotation there is always a side bending of the part that is rotated, the convexity of the curve being in the opposite direction to that in which the rotation takes place. If the rotation is to the left the convexity of the curve will be to the right and the bodies will be rotated toward the left. If the rotation is to the right the curve will be to the left and the bodies of the vertebrae will be rotated to the right.

It must be remembered that the dorsal region is the most rigid region of the spine, that this region is very little affected by hyperextension, that there is not much change in flexion, that lateral bending affects the dorsal region more than either of the other two mentioned and that rotation is the freest movement in the dorsal region.

### **Lumbar Region.**

In the lumbar region, as in the cervical region, the movements are freer and less hindered than in the dorsal region.

Flexion affects the lumbar region to a marked degree obliterating the anterior curve. In flexion the bending is quite evenly distributed over the entire lumbar region.

Hyperextension produces, by far, a greater change in the lumbar region than in either the dorsal or cervical regions and when the body is bent backward the greater part of the movement of the entire spine takes place in the lumbar region.

**Lateral Bending.**

In the lumbar region lateral bending is accomplished with greatest ease in the erect position and produces an evenly distributed curve along the entire region. In the extreme flexed position the side bending in the lumbar region is greatly limited.

When lateral bending takes place in this region the bodies of the vertebrae are rotated toward the concavity of the lateral curve, while in the dorsal region in side bending the bodies are rotated toward the convexity of the lateral curve.

**Rotation.**

It may be surprising to learn that this form of movement is extremely limited in the lumbar region and as a matter of fact in the flexed position is almost absent. In hyperextension, flexion, and lateral bending the lumbar region manifests great mobility. The dorsal region is more susceptible to rotation than to lateral bending while in the lumbar just the reverse is true, this region being more susceptible to lateral bending than to rotation.

PART X.

Abnormalities of the Spine

Curvatures

Exostoses

## Curvatures

A curvature is an abnormal bending of the spine and is named according to the direction in which the spine is bent. An abnormal bending of the spine toward the posterior is called a KYPHOSIS. An abnormal bending of the spine toward the anterior is known as a LORDOSIS, while an abnormal bending of the spine laterally is called a SCOLIOSIS. There may be a right or a left scoliosis. Then there may be an abnormal bending of the spine wherein there are two or more of these directions involved. A lateral curvature with a rotation would be called a ROTATORY-SCOLIOSIS or it might be called a KYPHOTIC ROTATORY-SCOLIOSIS, or a LORDOTIC ROTATORY-SCOLIOSIS.

It must be borne in mind that since these conditions are abnormal they are called curvatures. It is not necessary to say that they are abnormal curvatures for a curvature is abnormal. It is not necessary to say abnormal curve for the word curvature means abnormal curve. The word curve is used to designate a normal bending of the spine. Any of the curves of the spine may become exaggerated until they become curvatures. The posterior curve in the dorsal region may become exaggerated into a posterior curvature or kyphosis.

A curvature may be primary or secondary; direct or adaptative. A primary curvature is one that may be either direct or adaptative, but in either event it is the first abnormal bending to occur and there will be another curvature which

will be adaptative or compensative to this primary curvature. There may be a primary curvature resulting directly from a subluxation. This would make it a direct primary curvature. It may be the first curvature adaptative to some other abnormality or incoordination. In this case it would be a primary curvature adaptative to the other condition and at the same time there would very likely be another curvature adaptative to this one which would be a secondary curvature. Direct curvatures are always the direct result of subluxations while adaptative curvatures are compensative to some curvature or to some other incoordination or peculiarity. If one leg is shorter than the other there will be an adaptative curvature but a true secondary curvature is always adaptative to the primary curvature.

### **Kyphosis.**

A Kyphosis is an abnormal bending of the spine toward the posterior and may be classified as primary or secondary; direct or adaptative. It is not always necessary to palpate in order to determine a kyphosis, for visual inspection will always reveal the condition. An abnormal growth on the back may be mistaken for a posterior curvature but there is not much likelihood of this mistake being made since the palpation of an abnormal growth will not give the same impression to the palpator as the palpation of the spinous process in case of a kyphosis.

The palpator must use care in such cases that the normal bending of the spine be not confused with the abnormal. It is quite necessary to take into consideration the general build of the individual and to consider any peculiarities or idiosyncrasies, for it must be remembered that a bending of the spine in one patient that might be perfectly normal to that

patient, might not be normal to another patient. In other words, the normal bending of the spine, or the curves of the spine, are adaptations for the purpose of equalizing the weight of the body and if the weight be different in different individuals then we must expect the curves to vary. If the weight is increased at the anterior in the abdominal region the anterior curve in the lumbar region will be increased in ratio for the purpose of equalizing this weight and enabling the individual to maintain the erect posture without increased tension on the ligaments and muscles of the back.

A Kyphosis may be the direct result of a vertebral subluxation toward the posterior which makes the weight of the body greater on one part of that vertebral body or centrum than on the other parts, changing the perpendicularity of the line of support. Hence as time goes on the intervertebral disc, because of the unequal distribution of the weight, is changed in shape. If a weight bearing shaft be bent at one point it naturally becomes weaker at that point and will be more susceptible to change at that point by reason of the continual weight which it bears. So it is with the spine; the intervertebral disc continues to be changed and as time goes on the other adjacent vertebrae become affected. As the condition progresses greater pressure is produced until a well defined kyphosis is the result. In time the bodies of the vertebrae may become changed in shape, becoming thinner on the side of the concavity. In a kyphosis the anterior portion of the bodies of the vertebrae involved would become thinner.

The subluxation of a vertebra producing pressure upon a spinal nerve and interfering with the transmission of motor impulses to the spinal structures, such as the ligaments and muscles, that are attached to the vertebrae, these ligaments and muscles will lose their tonicity. If the interference be

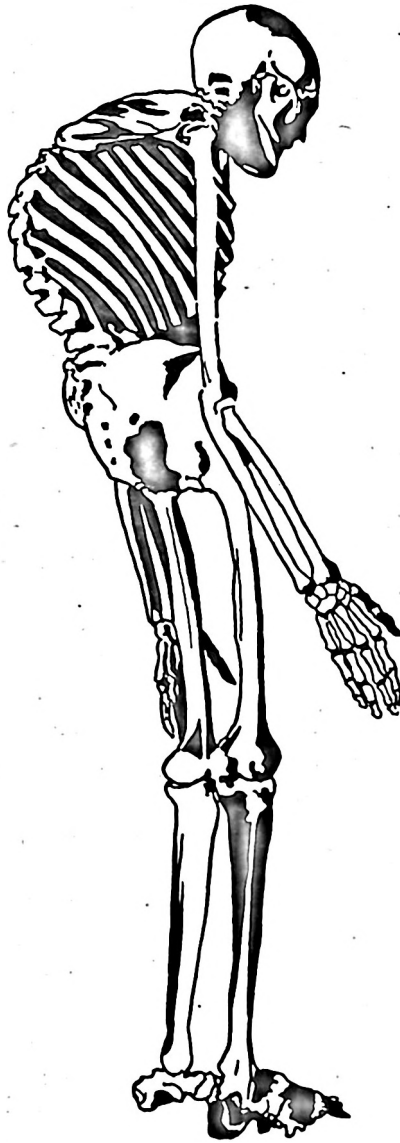


Fig. 92. Skeleton Showing Kyphosis.

the same on both sides of the spine then the lack of tonicity in the spinal structures will allow the spine to bend abnormally with the convexity of the bend toward the posterior.

The subluxation which is producing the pressure on the spinal nerve may be interfering with the transmission of nutrient mental impulses to the body of the vertebra or to the bodies of several vertebrae in the same locality. If this is the case then there is likely to be an NCR condition in the bodies of these vertebrae, producing a molecular decay and resulting in caries of the spine, spondylitis, or Pott's disease.

The bodies of the vertebrae being composed of cancellous bone tissue are very susceptible to this process of disintegration and are therefore affected more than the other descriptive parts of the vertebrae. As this process continues the bodies and the intervertebral disc are gradually softened under the weight of the trunk, which is greater than the supporting possibility of the centra and they become deformed. Usually this deformity takes place decidedly in the bodies of two adjacent vertebrae. As the deformity consists in the disintegration of the body and as this disintegration is greater at the anterior portion of the body it can readily be seen that there would be a decidedly sharp angular kyphosis at the point affected. The body of the vertebra affected may be almost entirely destroyed. In these cases Innate Intelligence brings about intellectual adaptative action by building up exostotic growths which consist in a development of healthy bone tissue on the adjacent vertebral bodies until these exostotic growths meet and form a support to the weakened portions. In the old cases and especially the arrested cases this is the condition that exists. The sharp angular kyphosis is held very firmly by this ankylosis. The ankylosis is purely

adaptative and no effort should be made to break it until the adjuster has made sure that the cause of the incoördination in the bodies of the ankylosed vertebrae has been found and removed. If the ankylosed vertebra is the causative subluxation, then it must be adjusted, but if an effort is made to break the ankylosis without finding the cause of the condition to which the ankylosis is adaptative the Chiropractor will be working against Innate Intelligence. The Chiropractor must be very careful that he does not "treat" effects in his care of curvatures of the spine. There must always be an effort to find a primary curvature. When this is found then ascertain whether it is direct or adaptative and proceed accordingly. It should be borne in mind that we never adjust directly for an adaptative curvature.

As has been stated a kyphosis may be an adaptative curvature. In that event it would be adaptative to an anterior bending of the spine or a lordosis. If the kyphosis is adaptative to a lordosis it will then be a secondary curvature compensating for the anterior bending of the spine in some other region. The Chiropractor never adjusts for an adaptative curvature of the spine but always makes an effort to find the cause of the primary curvature so that he can adjust the cause.

For the adjustment of Kyphoses see Volume 13, Page 477.

#### Lordosis.

A Lordosis is an abnormal bending of the spine toward the anterior and may be classified as primary or secondary; direct or adaptative. By far the largest percentage of lordoses are adaptative. There are several conditions that are conducive to the development of anterior curvatures of the

spine. An abnormal condition of the hip joint such as hip joint disease, fractures, dislocations and tuberculosis which would cause a stiffness of the joint necessitating the tipping of the pelvis in order to stand erect would tend toward the developing of a lordosis in the lumbar region. If the line of gravity is changed as in bilateral dislocation of the hip joints where the heads of the femurs are posterior to the sockets, the pelvis will be tipped downward at the anterior forcing an anterior bending in the lumbar region which serves to maintain equilibrium.

Another condition to which we find an adaptative lordosis is an increase in the weight in the abdominal region as in pregnancy and abdominal tumors. This increased weight at the anterior of the body changes the line of gravity. In order to equalize the weight of the body it becomes necessary for the supporting shaft which is located at the extreme posterior of the body to be bent toward the anterior directly opposite the weight that is to be supported. In most of these cases the lordosis is transitory and will disappear upon the disappearance of the weight of the anterior.

A lordosis may be adaptative to a kyphosis in some other region of the spine. The most common site of this curvature is the cervical region or the lumbar region. There are no structural changes that take place as the result of this anterior bending of the spine except in rare and exaggerated cases. The location of the lordosis which is adaptative to a kyphosis will depend entirely upon the location of the primary kyphosis. It is formed principally by a temporary change in the intervertebral discs which become thicker at the anterior and thinner at the posterior.

It must be remembered that this curvature is purely compensative and so equalizes the weight that the individual

may attain the erect position without undue exertion on the part of the spinal muscles. Before an adjustment can be given analysis must reveal, first, the condition to which the lordosis is adaptative and, second, the cause of that condition.

If the subluxations in the spine interfere with the transmission of mental impulses producing such condition as progressive muscular atrophy or kindred forms of incoördination in the muscles which weaken and destroy their tonicity, it will be found that there will be a developing of an exaggerated lordosis due to the fact that the patient throws the head and the shoulders back forcing the lumbar region toward the anterior, thus the spine is enabled to support the weight of the body and the equilibrium is maintained.

#### Scoliosis.

A Scoliosis is an abnormal bending of the spine laterally and it is named according to the direction of the convexity. If the convexity is toward the right it is a right scoliosis; if the convexity is toward the left, it is a left scoliosis. If the entire spine is involved in the scoliosis then it is called a total scoliosis right or left as the case may be. If only a part of the spine is involved then it is named according to the region which is affected. They are named as follows:

- A—a right or a left Cervical Scoliosis.
- B—a right or a left Cervico-Dorsal Scoliosis.
- C—a right or a left Dorsal Scoliosis.
- D—a right or a left Lumbo-dorsal Scoliosis.
- E—a right or a left Lumbar Scoliosis.
- F—a right or a left Total Scoliosis.

In palpating a case to ascertain a Scoliosis great care must be taken that the patient is sitting in a proper manner,

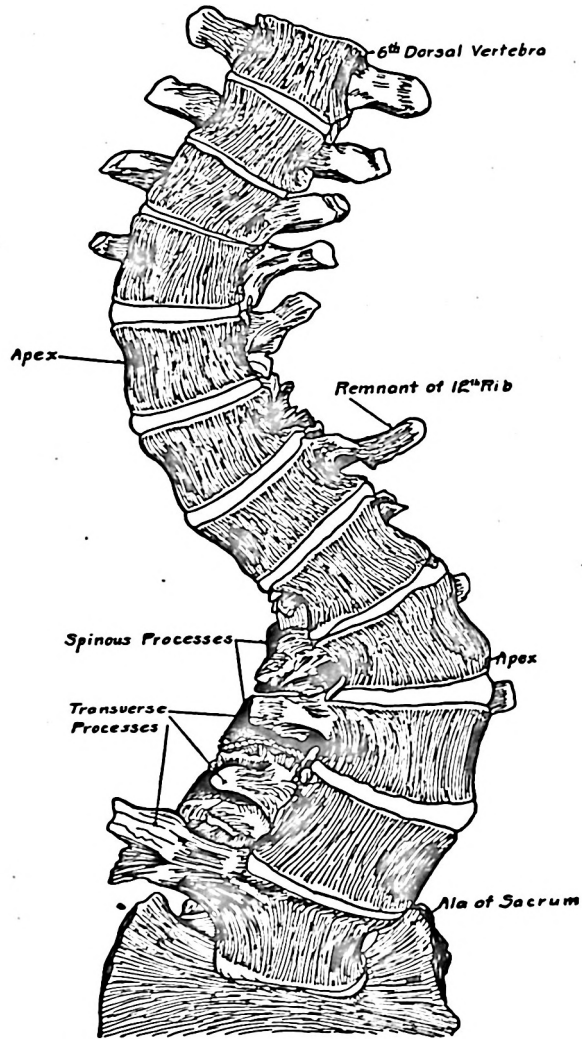


Fig. 93. Double Scoliosis—Anterior View.

as a faulty posture may produce a temporary lateral bending of the spine which may be mistaken for a Scoliosis. Particularly is this true in palpating children, especially small children.

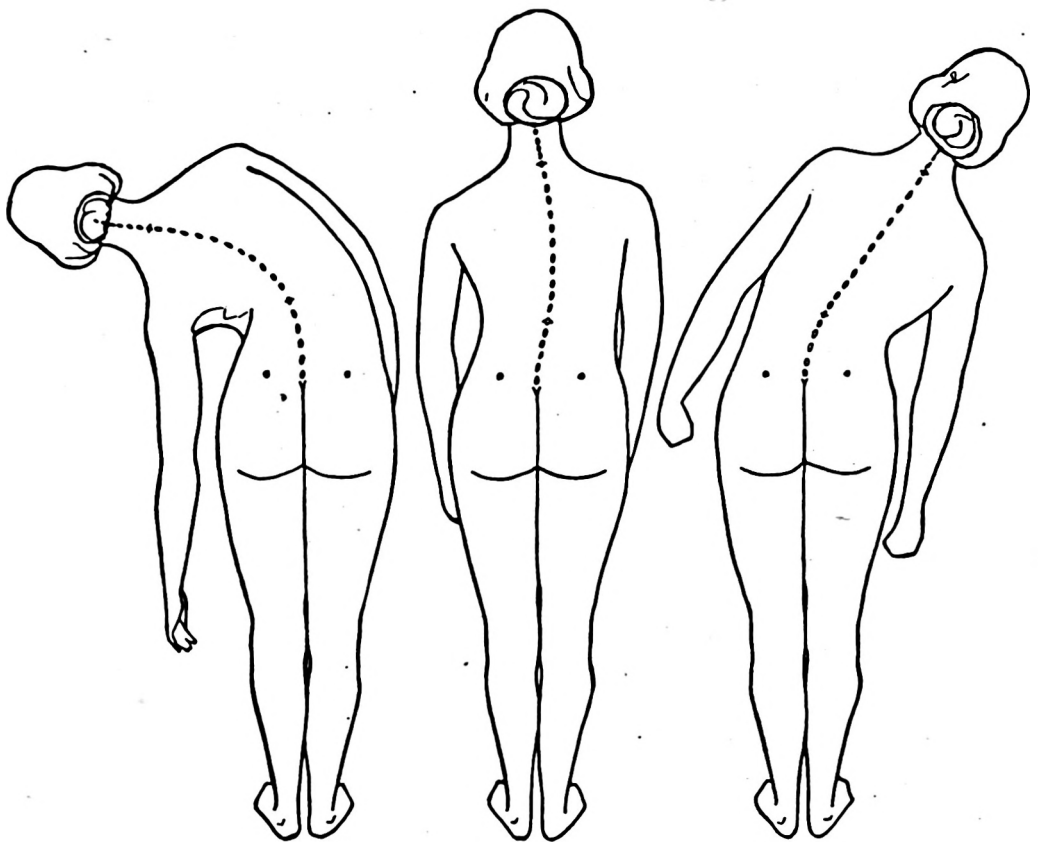
#### **Flexibility—In Lateral Curvature.**

The flexibility of the spine will always be affected by lateral curvatures, particularly in lateral bending or lateral flexion. Where there is a Scoliosis the lateral bending will always be decreased when the patient bends laterally toward the convexity of the curvature and increased when bending the trunk in the opposite direction. In other words in a right Scoliosis there will be greater lateral flexion of the body toward the left and less flexibility when the patient bends the body toward the right as shown in Figs. 94, 95, 96.

#### **Posture.**

A total lateral curvature of the spine produces a gradual lateral bending of the entire trunk. The shoulder on the side of the convexity will be higher than the opposite one and the ilium on the side of the concavity will be higher than the opposite ilium. To illustrate: If the case is one of a right total scoliosis, the right shoulder will be higher than the left but the left ilium will be higher than the right ilium. The distance from the left shoulder to the left ilium will be somewhat less than the distance from the right shoulder to the right ilium. On the other hand, if there is a compensating curvature somewhere in the spine it will be found that these deformities of posture will be corrected and the shoulders will remain in the same plane relative to each other. See Fig. 99.

In total curvature the apex is most frequently found in



Figs. 94, 95, 96. Showing Flexibility of Spine in Total Scoliosis.

the lower dorsal region. It may be as high as the ninth dorsal or as low as the second lumbar vertebrae. This form of curvature is not very common for the reason that in the majority of cases there will be a compensating curvature in the opposite direction which will permit the body remaining in an erect posture without the symmetry of the trunk being disturbed. According to Lovett, the greatest deviation from the medial line is not often more than an inch and a half.

With a total lateral curvature the bodies of the vertebrae will be rotated toward the convexity of the lateral curvature. This is due to the fact that in lateral bending, with forward flexion of the spine, the bodies of the vertebrae will be rotated in the direction of the convexity as explained under Movements of the Spine.

Lateral bending of the entire normal spine in the erect position is accompanied with the rotation of the bodies of the vertebrae toward the side of the concavity, but this is not true in the abnormal spine. As a matter of fact the opposite is more often true. In the normal spine in the erect position lateral bending is accompanied with a rotation of the bodies toward the side of the concavity of the lateral curve but in the abnormal condition as in a scoliosis the bodies are rotated toward the side of the convexity. There are exceptions, however, to this rule for the rotation is governed largely by the cause of the curvature.

#### Habit Scoliosis.

Habit Scoliosis seldom, if ever, produces pathological changes in the vertebrae although there is more or less deformity of the body in lateral curvature of the spine.

Curvature of the spine may be caused by faulty position during a long period of time, especially during the time that

the spine is developing. Young bone is plastic; it is susceptible to change. If an infant is kept in the same position for long periods of time there is likely to be a gradual change of the bones resulting in curvature of the spine. If the change in the shape of the vertebrae vary to any great extent the curvature will be permanent and will not yield to adjustments. In such cases there is usually very little pressure produced on the nerves for the reason that the change takes place so gradually that Innate Intelligence has an opportunity to bring about an adaptation in the intervertebral foramina so that the pressure may be removed or at least so that the shape of the foramen may be adapted to the needs of the nerve. This is possible from the fact that the bony structure which makes up the boundries of the foramen are plastic and easily changed in their shape.

A scoliosis may develop in the cervical region as a result of impaired sight causing the patient to hold the head in a peculiar position for the purpose of focusing the eye to rays of light. Such a curvature results as an adaptation.

#### **Occupational Scoliosis.**

Curvatures of the spine, and particularly the lateral curvatures may result from the character of work a person performs. An occupational curvature is one that is adaptative to the occupation, and may or may not, require adjustments. If the curvature is a pathological condition then it should be adjusted, but if it is adaptative to the occupation compensating for the position assumed when work is being performed, then it should not be adjusted unless the occupation is changed.

There are many occupations to which we find adaptative and compensating curvatures. It is not our purpose to give a list of all such occupations but to mention a sufficient num-

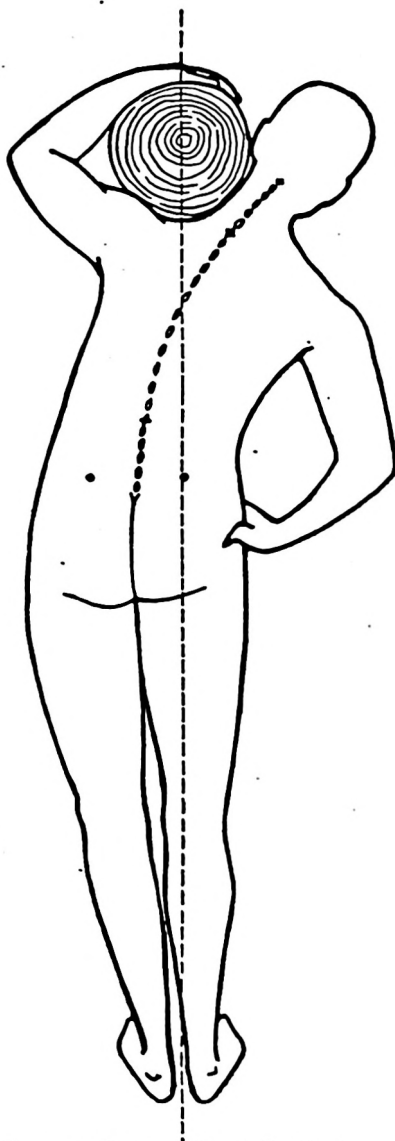


Fig. 97. Occupational Scoliosis.

ber to give the student an idea and he may then be able to recognize the occupational curvatures regardless of the occupation to which the particular curvature is adaptative.

Any occupation which would result in the development of the muscles of one side of the back more than the other would tend to cause a scoliosis. This would be due, partly to the over development of the muscles making the greater pull on one side of the spine, or it might be due to constant strain on the spine from the effort that caused the muscular development.

Carrying a weight on one shoulder would have a tendency to cause the spine to bend in the direction of the weight carrying shoulder. In hod carriers, where the weight is carried continuously on one shoulder, there will be a lateral bending of the spine for the purpose of equalizing the weight, the spine bending toward the weight bearing side.

Writing at a desk which is too high, as many children are compelled to do in schoolrooms, may result in a lateral curvature. Working as a cabinetmaker is sometimes responsible for a scoliosis. Professional violinists will usually be found to have a lateral curvature, due to the attitude assumed in playing the violin.

Any occupation, in which the worker assumes certain positions for any great length of time, so that the spine is bent out of the normal median line, is very likely to result in a curvature of the spine. Many of these curvatures may remain as permanent conditions but others may disappear when the occupation is changed. There are some curvatures for which adjustments should not be given unless the occupation is changed, conditions where the curvature is purely adaptative to the occupation.



*Anterior View—showing wedge-shaped  
Bodies*

Fig. 98. Wedge Shaped Vertebral Bodies in Left Scoliosis.

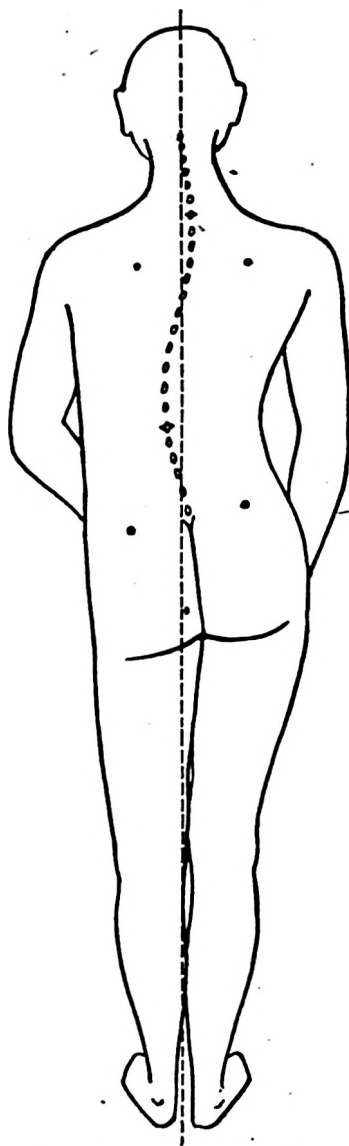


Fig. 99. Static Scoliosis.

The physical changes that take place in lateral curvatures of the spine must receive careful consideration. The shape of the segments will be changed and in some cases greatly distorted. Especially is this true in the bodies of the vertebrae involved. These distortions may be congenital or they may be due to pathological results such as paralysis, empyema or the changes may be due to the weight of the trunk upon the bodies of the vertebrae which have been thrown out of the median line of the body as an adaptation to some such condition as a short leg or a tilted pelvis.

**Effect upon the bodies of the vertebrae:**

The bodies of the vertebrae will be affected more than any of the other parts because they support the principal weight of the trunk. They may become typically wedge-shaped. See Figure No. 98. Those in the angle of the curve are affected more than the others, becoming thinner on one side than the other. The bodies of the vertebrae at the apex of the curve and those immediately above and below will be thinner on the side of the concavity. If the curvature is a left scoliosis the bodies of the vertebrae involved will be thinner on the right side. The superior surface of the vertebrae immediately below will be affected more than the superior surface, while the inferior surface of the vertebrae above will be affected more than the superior surface; both the upper and the lower surfaces may be equally involved.

**Static Scoliosis.**

Static Scoliosis is a lateral bending of the spine adaptive to a short leg. It develops for the purpose of throwing the center of gravity over the center of support. The bodies of the vertebrae involved may not be changed in shape but the curvature may be due entirely to the change in the inter-

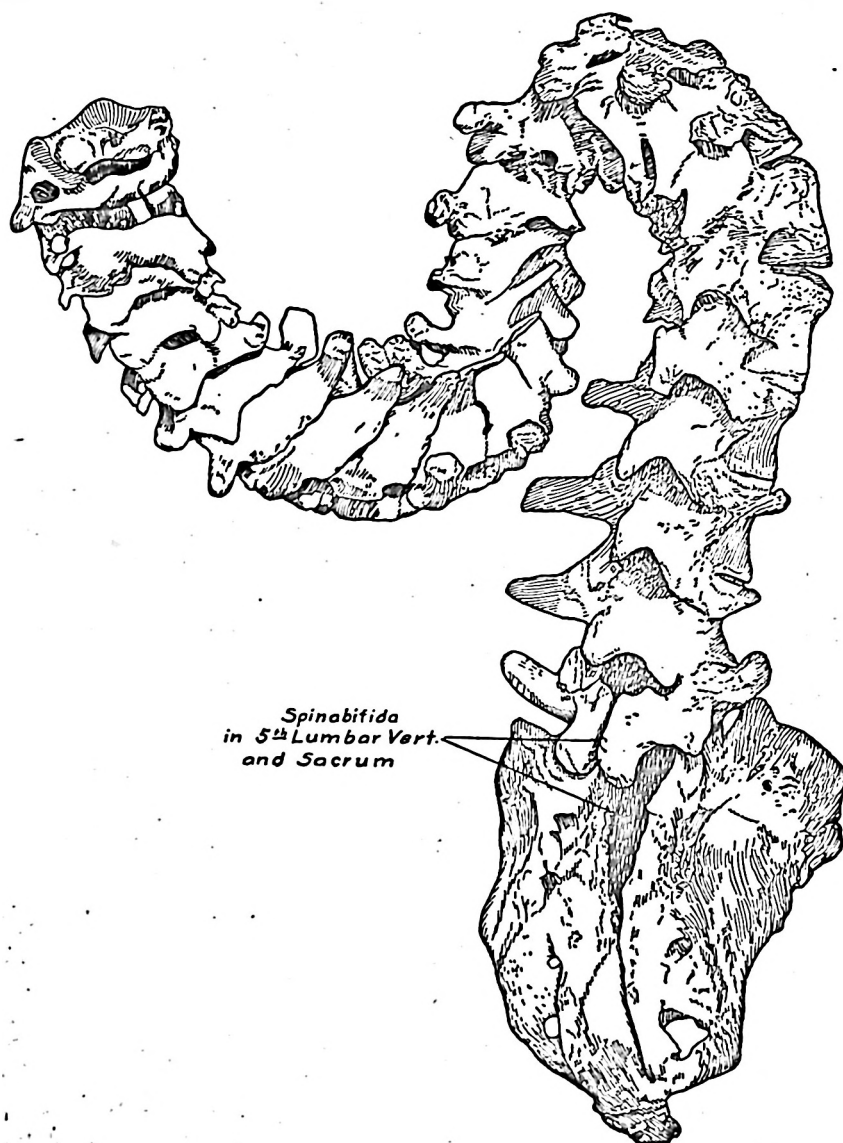


Fig 100. Rotary Scoliosis.

vertebral discs. If this condition remains for a long time, as likely it will when adaptative to a short leg, the bodies of the vertebrae will very likely become wedge shaped because so much of the weight is thrown on one side of the bodies. If there is no great difference in the length of the legs, the curvature will be slight. If the legs later become the same length, as does occur in some cases with growing children, the adaptative curvature will disappear. However, if the leg is permanently shortened by fracture, congenital hip dislocation or any of the other numerous conditions that might obtain, the curvature will become permanent.

#### Rotatory Scolosis.

A rotatory scolosis is a lateral bending of the spine with a rotation of the vertebrae. In the large majority of cases where there is a scolosis it will be found that there is also a rotation. By rotation is meant a condition where the bodies of the vertebrae are rotated on their sagittal axis. Usually, the bodies are rotated in the direction of the laterality of the curvature.

In a right rotatory scolosis the convexity of the curvature is toward the right and the bodies of the vertebrae involved are rotated more to the right than the spinous processes; this makes the transverse processes more prominent on the right side than on the left.

In the extremely exaggerated cases of rotatory scolosis the rotation may be so great that the transverse processes are found to be in the median line and in palpation are likely to be mistaken for the spinous processes.

The accompanying illustration, Fig. 100, shows a double rotatory scolosis greatly exaggerated. This is an unusual condition and is shown here merely that the student may see to what extent a curvature may obtain in the spine. It would

of course, be a physical impossibility to correct such a condition.

This is but one of the many specimens that are to be found in the Osteological Studio of the Palmer School of Chiropractic, to which the student has access at all times during his course.

### Exostosis

An exostosis is an outgrowth of osseous tissue from the surface of a bone, or it is an excessive growth of osseous tissue attached to a bone. Exostoses are classified as true and false. A true exostosis is a condition wherein there is a true development of bone tissue which may occur on any of the bones of the body and may be associated with many abnormal conditions. The condition itself is a disturbance of the function and the equation is Expansion Plus. The condition is the result of bone proliferation which may be induced by heat or it may be the direct result of intellectual adaptation whereby Innate Intelligence makes an effort to compensate for some abnormal condition.

#### Exostosis Caused by Inflammation.

In true exostosis caused from excessive heat there is a proliferation of bone cells, especially in the periosteum resulting in its ossification. When there is an inflammatory condition in the spine due to arthritis, osteitis and spondylitis, wherein the periosteum is involved, there is likely to be an excessive growth. This is sometimes on the body or it may be on any of the other descriptive parts of the vertebra.

In some cases the exostosis may form on the spinous processes of the vertebra causing great unevenness and giving them the appearance of being subluxated. This should be taken into consideration in palpation. In some cases it may

be impossible to detect an exostosis, yet in many cases it may be detected by very careful palpation. If careful palpation does not reveal, beyond doubt, the exostotic growth, then a spinograph picture should be taken. The most common location in the spine of exostotic growths is on the spinous processes in the lumbar region.

### Trauma.

Trauma is responsible for a great many exostotic growths in the body. The callous that is formed around the fractured ends of a broken bone may become ossified leaving an enlargement after the fracture is healed. A green stick fracture of a spinous process may occur. This, of course, would bend the spinous process out of the median line, but if in the healing of the fracture there should be an exostosis formed the Chiropractor would have not only the bent spinous process with which to contend but also the deformity caused by the exostosis. If this condition occurs in the dorsal region the transverse processes may be palpated, but as these are not exempt from abnormalities of this sort, we can not rely upon them entirely. The palpation may be verified, in a measure, by nerve tracing, but even then it is impossible to determine the combination of directions in which the vertebra is subluxated so that a deformity of this sort is suspected. Great care and judgment should be exercised in making the analysis. A very careful history of the case should be taken to determine any accident that might have occurred or any force that might have been applied to the spine sufficient to fracture the spinous processes or produce any other injury. Even then the analysis should not be considered complete until a spinograph had been made of the region involved.

**Adaptative.**

Many of the exostotic growths encountered will be found to be adaptative. Especially is this true of the exostotic growths found in the spine. If the muscles on one side of the spine were weakened as a result of interference with the transmission of mental impulses caused by a vertebral subluxation, the spine would be bent accordingly, with the concavity of the curvature toward the side of the weakened muscles. Because of the lack of coordinate action between the two sets of muscles, Innate Intelligence would make an effort to compensate for this lack of muscular tonicity and to prevent the spine from bending farther away from the median line, would build up exostotic growths. This outgrowth of bone would be of normal healthy tissue and would result in the union of the segments involved. This would destroy the movement between the vertebrae, but it would make the region very firm and solid. In this way the spine would be held firmly and the curvature prevented from becoming more exaggerated.

In these cases the exostoses are most often found on the bodies of the vertebrae; partly because they are formed of more cancellous tissue and are therefore more susceptible to such changes, but more particularly because the bodies of the vertebrae support the weight of the trunk. Therefore, greater strength is secured by the strengthening of this central weight bearing shaft by developing the exostoses here rather than on the other parts of the vertebra. For instance, suppose the spinous processes were ankylosed in case of a lateral bending of the spine. This would not be much toward strengthening the spine against lateral bending. Since the bodies bear the weight they might still be rotated by reason of this weight even though the spinous processes were held firmly together by exostotic growths.

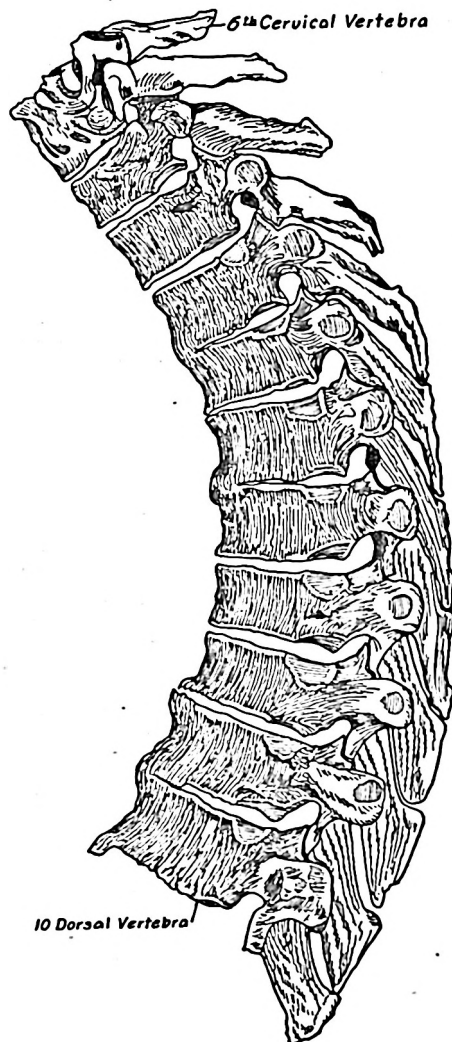


Fig. 101. Kyphosis in the Dorsal Region Showing Adaptative Exostosis and Ankylosis.

While the body of the vertebra is the most common site for exostoses, the transverse processes are often found to present exostotic growths. It can readily be seen that quite a degree of strength could be obtained by this method and particularly if there was a tendency toward a rotation of the spine.

Since an exostosis of the character just described is purely adaptative, the first thing for the Chiropractor to do is to determine the condition to which the ankylosis, due to the exostosis is adaptative. Then find the subluxation which is interfering with the transmission producing the condition and adjust that subluxation, not necessarily for the purpose of removing the exostosis and breaking the ankylosis, but for the purpose of removing the pressure that is causing the abnormal condition to which it is adaptative. When the condition is corrected Innate Intelligence will begin her readaptation for the purpose of removing the exostosis. But if an effort be made to forcibly break the ankylosis without removing the cause to which it is adaptative, the Chiropractor will be working in direct opposition to Nature.

If the causative subluxation is ankylosed, it can not be moved until the ankylosis is broken, but when this is accomplished the vertebra may then be moved and thus the cause of the condition to which the ankylosis is adaptative will be removed. After this takes place the exostosis will not be rebuilt, since there is no longer a need for this adaptation. But if an ankylosis is adjusted and broken without correcting the causative subluxation, the exostosis will reunite again and reform the ankylosis.

#### **False Exostosis.**

A false exostosis is an enlargement due to pathological changes which have taken place in the bone tissue, but not the

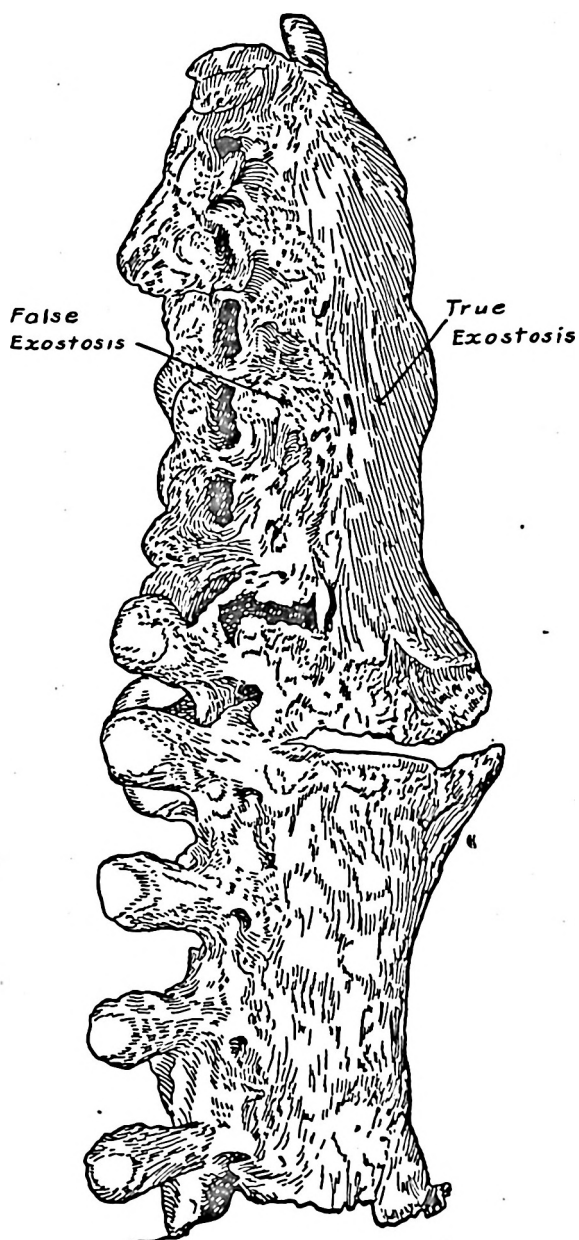


Fig. 102. Cervical and Upper Dorsal Regions Showing True and False Exostosis and Ankylosis.

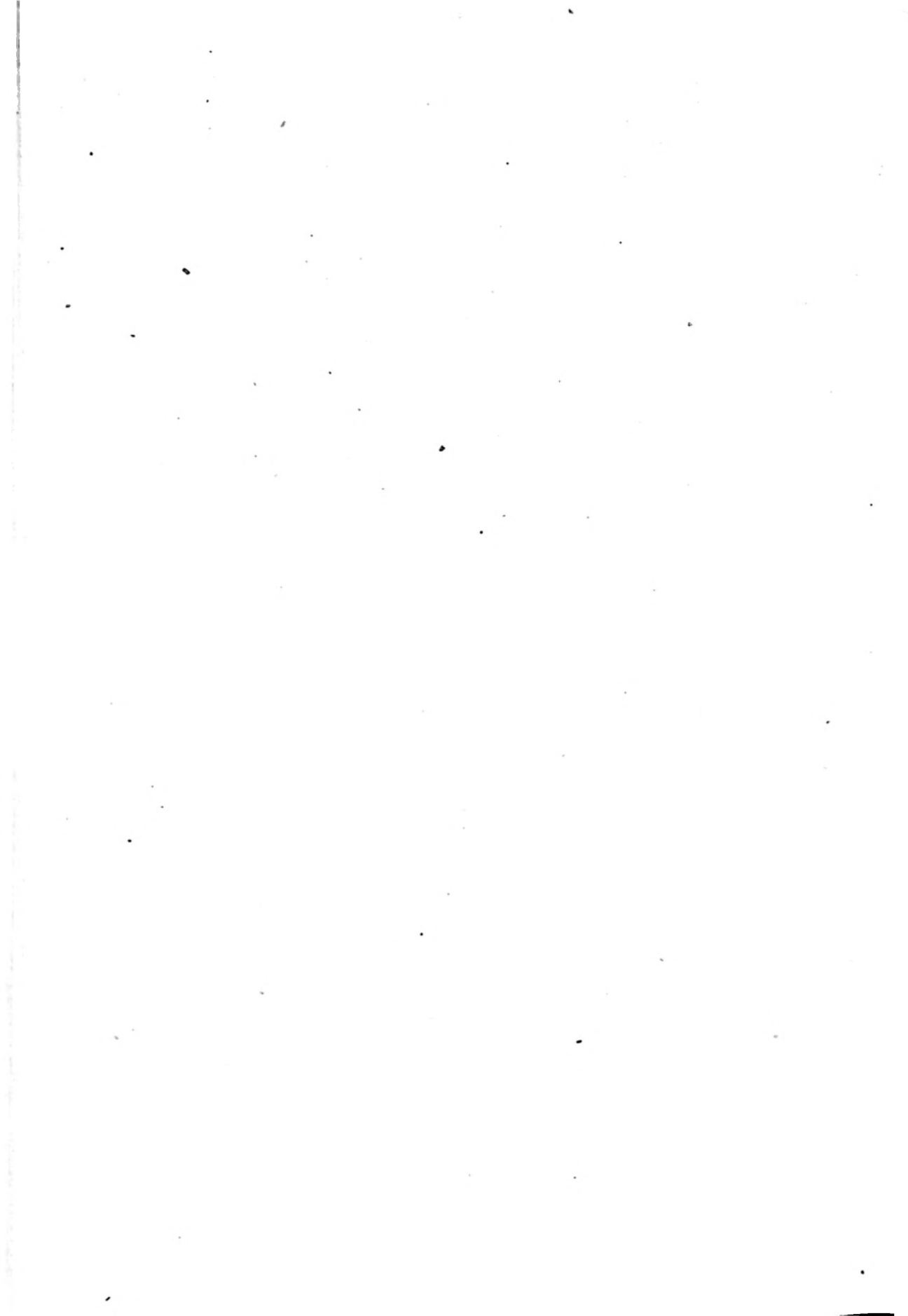
result of the development of new bone tissue. This is usually the result of a softening of the bone tissue due to excessive heat. The bones become soft and the natural weight of the trunk on the vertebrae causes them to give way and bulge. A false exostosis may be formed on any of the bones of the body, but particularly on the spine. The condition is commonly associated with inflammatory conditions, more especially with tuberculosis, Pott's disease, and caries of the spine, wherein there has been an excessive amount of heat in the bodies of the vertebrae, causing them to give way under the weight of the body. It is not uncommon in such cases to find both true and false exostoses existing in the same case.

The false exostosis is in no way adaptative and is always pathological. While true exostoses may be found on any of the descriptive parts of the vertebrae, especially the bodies, false exostoses very rarely affect any part but the bodies of the vertebrae. Since false exostoses are due entirely to the softening of the bone, from excessive heat, seldom do the more solid bone of the other descriptive parts of a vertebra become involved in this heat. In many cases the bodies of the vertebrae involved become so fused that it becomes impossible to find the line of demarkation between them.

Since false exostoses are almost always formed on the bodies of the vertebrae, it is not often that they cause any confusion in palpation. Of course, if a false exostosis should form on the spinous process it would lead to confusion in palpating the spinous process.

The heat, causing a false exostosis, may be so extensive as to involve a great number of vertebrae and it may be so excessive that the ligaments will become affected by it. Especially is this true of the intervertebral discs. They may become soft because of the heat and give way under the

weight of the body. As a result the surfaces of the bodies may come together and form a very solid ankylosis. When this condition exists it can readily be seen that it would be impossible to correct such a condition. If the intervertebral disc is once destroyed and the bodies of the vertebrae unite as a result of the fusion of the bone, it would not be within the bounds of possibility to again separate the bodies and replace the intervertebral discs. It is not wise to make any effort to adjust in such a condition. For instruction in adjusting true and false exostoses see Vol. XIII.



**PART XI.**

**Diseases of Bone**

## Diseases of Bone

### Tuberculosis of Bone.

Tuberculosis of bone is an infection of the bone tissue in which the tubercle bacilli are found. It may involve any of the bones of the body. The seat of the infection is in the osseous tissue and not in the periosteum. As a result of the pressure on the nerves the bones may be poorly nourished. The arteries become blocked and nodules spread through the poorly nourished region. As a result of the caries (molecular decay) cavities are formed. The bones are dissolved by the masses of granulations and these cavities become filled with cheesy pus. Necrosis may occur wherein the bone dies from lack of nourishment and parts become separated from the healthy tissue and lodge in the bony cavities surrounded by pus and granulations. The pus which forms is thin and contains "bone sand." There are very few bacteria in this pus which goes to show that tuberculosis bacilli are not the cause of the condition.

Tuberculosis of the bone may appear after an injury to the bone. If the affection is near a joint it is very likely to invade it and cause what is known as "Tuberculosis Osteoarthritis." The formation of pus may occupy a long period of time as the process is usually very slow. The pus will follow the line of least resistance and form abscesses known as "gravitation abscesses."

In any incoordination of the body there is always a marked tendency toward adaptation. The intellectual adapta-

tion in this disease is characterized by a pronounced effort on the part of Innate Intelligence to "wall of" the diseased parts. Innate Intelligence builds capsules around the affected part as a means of isolation. The tubercle bacilli may live for many years in these capsules. There may be in this process of adaptation swellings on the bones from the periosteal excrescence.

**Symptoms:** The symptoms may be difficult to recognize as they are very insidious. There may be practically no pain as the abscesses form very slowly. There will be very slight fever and the local disturbance will be slight.

#### **Tuberculosis of Joints.**

When bone becomes tubercular and the site of affection is near a joint, it may pass into the joint and produce OSTEO-ARTHRITIS. Miliary tubercles form on the inside of the synovia, an NCR condition is produced and there will be perforation into the cavities of the joints, the pus filling the joint and destroying it. The articular cartilage is torn from the bone and pus forms between. The granulations which form are soon broken down, forming a cheesy substance. The joint is soon filled with this purulent suppuration which destroys the ligaments. There is an adaptative process in which the capsule is thickened, but the pus will finally break through and form an abscess.

The condition may remain at the primary exudate stage, in which the swelling disappears from the joint. This is known as Tuberculosis Rheumatism. In old people a dry form may appear in which the joint is destroyed without the formation of pus. This form rarely affects children. Children are more frequently affected by the form in which slowly growing granules fill the joint and are gradually broken down.

There may or may not be a primary exudate. There will be characteristic swelling of the joint which makes the skin tense and glistening. If the process, however, is not soon arrested the breaking down of the granules will form a joint abscess. The symptoms depend upon the joints which are affected, but the diagnosis is very much the same as in tuberculosis of the bone.

The prognosis is much better in children than in adults. Even though the ends of the bone do not grow together, the joint will be stiff because of the fibrous scars which involve the capsule and the ligament. However, the joint is generally destroyed.

#### **Tuberculosis of the Shoulder Joint (Omarthritis).**

The shoulder joint is not a very common site for tuberculosis. When found, it is usually of the dry type which is called Caries Sicca. Traumatic Omarthritis is very rare in childhood, but occurs more often in adult life. It must not be mistaken for Omarthritis or inflammation of the shoulder joint due to tuberculosis.

The first symptoms to appear may be a collection of fluid in the joint. The growing masses of granulations and the primary exudate distend the capsular ligament and produce an enlargement of the joint. The shoulder protrudes and the Deltoid muscle has the appearance of being swollen, but this is because of the enlarged joint.

There is a marked NCR condition. The head of the humerus may be entirely destroyed by the molecular decay and become very tender on pressure. Because of this tenderness there will be as little movement as possible to reduce the pain produced by the friction of the movement. The Deltoid muscle will atrophy as a result of non-use. The pus resulting

from the process of decay perforates the capsule and forms a cold abscess posteriorly below the scapula or in the axilla, or it may follow the Biceps muscle into the upper arm. The axillary glands are always affected and will be enlarged and inflamed. The epiphyseal line lying within the cavity of the shoulder joint is destroyed and this results in the shortening of the arm.

The joint becomes entirely stiff. At first it is the result of the muscular contracture, but later it results from ankylosis of the joint, or during the process of reparation there is formation of fibrous scar tissue which stiffens the joint. After the joint becomes ankylosed then a movement of the shoulder will be the result of the scapula moving on the thorax. As a result of the stiff shoulder joint, there is likely to be a curvature of the spine, usually a scoliosis.

Because of the close proximity of the lungs to the location of the incoördination, there is danger of the pus perforating into the lung cavity. Therefore, the prognosis is not very favorable. However, if adjustments are given in time the process of destruction may be overcome and good results obtained.

## Tuberculosis of the Spine

Caries of the spine is a tubercular inflammation of the bodies of the vertebrae, although other descriptive parts may be involved. Any part of the spine may be affected, but the condition is most often found in the lower dorsal and lumbar regions. The Cervical region is least often affected. The disease usually affects from two to five segments of the spine. As the bodies of the vertebrae are softened by the molecular decay, the weight of the trunk presses them together, producing a typical kyphosis found in Tuberculosis of the spine. Although at the beginning there may be a lordosis, this is very soon displaced by the posterior curvature. The body may be made perceptibly shorter because the spine gives way under the weight.

Farnum states that in the majority of cases the etiology may be traced to some injury. The traumatism may have been very slight, but if the history is obtained with care, in the majority of cases it will be found that at some time, perhaps long before the development of any symptoms of Pott's disease, the child received a fall or some rough handling, resulting in a "TRAUMATISM OF THE SPINAL COLUMN, WHICH WAS FOLLOWED FOR A SHORT TIME BY SENSITIVENESS IN THAT REGION." This is very true, for the injury resulting from a "fall or some rough handling" was a subluxation which interfered with the transmission of nutrient mental impulses to the bodies of the vertebrae and the result was an NCR condition. ("NCR" means nutrition minus, calorific plus, and reparation minus). This molecular

decay begins in the center of the bodies of the vertebrae and proceeds toward the circumference until the bodies may be practically all eaten away, the periosteum, ligaments and contiguous structures all become involved. In exaggerated cases the membranes of the cord and even the cord itself may be affected.

Abscesses may form in any of the regions of the spine that may be affected. This is the result of the NCR condition, or the suppurative process in the bodies of the vertebrae. The pus follows the line of least resistance and forms "cold abscesses."

The symptoms at the onset may be misinterpreted. They appear very gradually and progress for a long time unnoticed. As a matter of fact the deformity may be the first symptom observed. Among the first symptoms will be pain along the course of the nerves due to the intervertebral pressure. There may be a rigidity of the muscles of the spine as an adaptative measure for the purpose of diminishing the movements of the affected parts in order that the pain may be reduced. The patient is very likely to assume different postures for the purpose of relieving the pressure on the diseased bodies of the vertebrae. There may be in some cases paralysis from the intervertebral pressure. There may also be signs of local abscesses. The patient may be restless at night, moving almost continually in his sleep. The face usually assumes an anxious expression.

#### **Cervical Region.**

When the disease is located in the cervical region there will be pain in the Occipital region and in the neck; the pain is aggravated on movement. There may be slight torticollis and sometimes slight opisthotonos and all the movements of

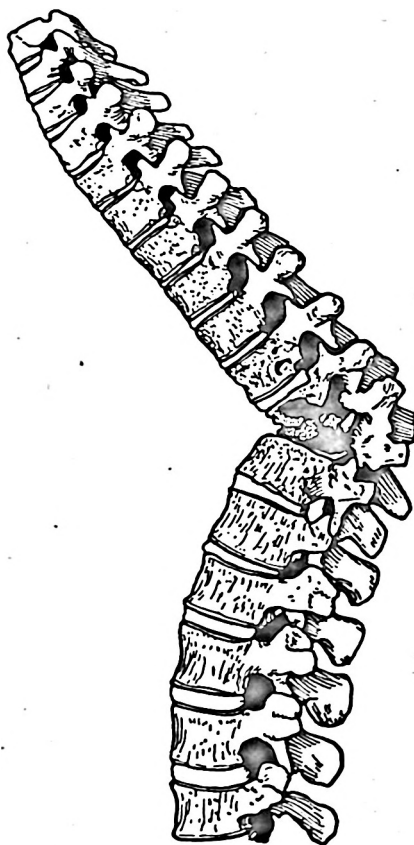


Fig. 103. Spine Showing Caries.

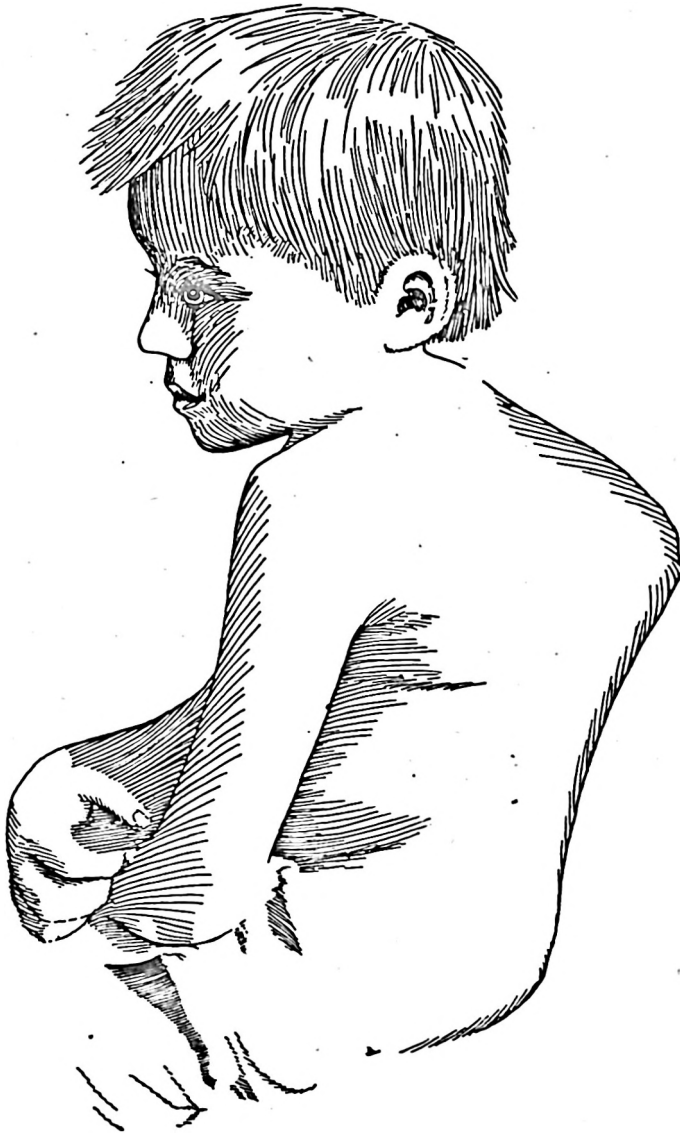


Fig. 104. Kyphosis in a Case of Caries of the Spine.

the neck are resisted. The neck appears broad and short and the patient may steady the head with the hand. If the condition is in the lower cervical region there will be a kyphosis, but if in the middle cervical region there will be a lordosis.

#### Dorsal Region.

If the incoördination is in the dorsal region the pain will resemble intercostal neuralgia or there may be pain in the abdominal region. The symptoms may be mistaken for those of an ordinary cold or indigestion. If the upper dorsal region is the part affected the shoulders will be held higher than normally, the head will be thrown slightly backward, causing a slight lordosis in the cervical region. The back, below the affected part, will be straight, with a tendency for the anterior curve in the lumbar region to be decreased. In the middle dorsal region the attitude is spoken of as "Military," on account of the fixation of the muscles and rigidity with which the body is held.

The patient will be inclined to assume such positions as lying across a chair or a stool, for this has a tendency to relieve the pressure produced by the backward bending of the spine. Very early the characteristic kyphosis will develop

#### Lumbar Region.

About the first symptoms to result from caries in the lumbar region will be pain and weakness in the lower extremities. There may be a tilting of the pelvis toward one side with a marked lateral curvature of the spine. The gait is characteristic; the patient walks with as little movement of the spine as possible. This is spoken of as "walking with the legs but not with the spine." In walking, the patient shuffles his feet, keeping them close to the ground. The shoulders are



Fig. 105. Exostosis and Ankylosis Due to Tuberculosis of the Spine.

thrown back and the spine held stiff. The patient walks with very short steps, and great care is taken not to jar the spine, as any jar or jolt will produce pain. In time the typical kyphosis will develop.

### Spinal Deformities

With this general knowledge of caries of the spine we will now consider more carefully the spinal deformities resulting from this incoördination. As has been stated, the bodies of the vertebrae being of cancellous tissue, are more susceptible to the destructive process than the other parts of the vertebrae. Since the bodies form the chief support for the weight of the trunk they easily give way under that weight when the bone becomes diseased. Therefore, the most common deformity in caries of the spine is a posterior curvature. The spinous processes of the affected vertebrae become very prominent and the angle of the curvature will be in ratio to the destruction in the body of the vertebrae. If the process of destruction involves the bodies of two vertebrae and they are destroyed at the anterior, then the weight of the trunk will press them together and the angle of the curvature will be very acute. This is spoken of as a "sharp angular kyphosis."

If the destructive process is confined to only one side of the bodies of the vertebrae then there will be a lateral curvature, due to the fact that the bodies in the diseased area are not able to support the weight of the trunk on that side. When such is the case an adaptative curvature will appear in some other regions of the spine. If the primary curvature is a kyphosis the adaptative curvature will be a lordosis. If the primary curvature is a lateral one then the adaptative curvature will be a scoliosis in the opposite direction.

**Chronic Deformity.**

After the process of destruction has been arrested it will be followed with a permanent kyphosis, which is held very firmly by an ankylosis. There will be an exostosis built up by Innate Intelligence for the purpose of strengthening the region. The patient may remain in this condition for years with little inconvenience other than the stiffness caused by the ankylosis. In adjusting such cases great care should be taken that the ankylosis is not broken by the adjustments before the cause of the caries is removed. The student is referred to the Palmer Technique of Chiropractic, Volume 13, for instruction in adjusting such conditions.

## Osteogenesis Imperfecta or Osteopsathyrosis

Osteogenesis Imperfecta means imperfect origin of the bone tissue. It is a term applied to a prenatal condition which is characterized by a brittle condition of the bone which may result in intrauterine fractures. Osteopsathyrosis, or Lobstein's disease, is the term which is applied to the postnatal condition.

There is a marked decrease in the number of osteoblasts, and also in their activity which interferes with the formation of bone, both in the periosteum and in the bony trabiculae. The cartilage itself is not affected so the length of the bones will be normal, except that they are made shorter by the intrauterine fractures. The shortening of the limbs from fracture may produce a condition which resembles chondrodystrophy. The intrauterine fractures may result in great deformities of the bones in any part of the body. The treatment is usually through dietetics. Chiropractically, the condition is the result of an abnormal condition existing in the Serous Circulation.

Pathology is found in all the bones of the body, but in no other tissue. A great many of these cases die soon after birth; some survive and the bones grow firmer as the child develops. In all cases, fractures are easily produced and in severe cases they may result from the slightest provocation. Even with the most careful handling of the infant, fractures may occur, and in the adult the most trifling injury may result in a broken bone. Bones may be broken by the individual

performing the ordinary functions, as breaking the jaw while masticating food. As the formation of callus is very slow, the fractures are likely to be late in healing.

The bones of the skull may be defective and the sutures widely separated. If the patient reaches maturity, the bones may become less brittle. Usually, the greatest improvement is noticed about the age of puberty. The general health of the patient may be good notwithstanding this extreme fragility of the bones.

In these cases great care should be exercised in adjusting and in the extreme cases there is such great danger of fracturing the vertebrae that it may be impossible to adjust. The major would be C.P. and K.P.

#### Effects Upon the Spine.

There may be curvatures of the spine produced by abnormalities resulting from the fractures of the bones. If the bones of the lower extremities become unequal in length as a result of fractures, as is often the case, there will be a corresponding scoliosis in the spine. There may be fractures of the bones of the thorax, producing deformity, which would necessitate adaptative curvatures of the spine as a matter of compensation. As there are no bones of the body that are exempt, even the spine itself may be affected directly, and a curvature may result from the injury to the spine.

## Chondrodystrophy (Acondroplasia)

Chondrodystrophy is a congenital condition due to a disturbance in the development of bone tissue. It is sometimes called Congenital or Foetal Rickets. The pathology consists in the disturbance of the normal ossification of primary cartilage, the intra-membraneous ossification being normal. The flat bones are, therefore, not affected. The disturbance is at the junction of the epiphyses with the diaphyses. Chondrodystrophy is often mistaken for rickets, cretinism and osteogenesis imperfecta. Chondrodystrophy is the cause of most cases of true dwarfism. It was known to the ancients and according to the best authorities the old "court Jesters" were chondrodystrophics. Medically, the etiology is unknown.

A great number of these cases are born dead; those who live are frail as infants. There may be a marked motor minus condition in the muscles which will delay walking. Later in life the patient may become strong and muscular. The health of the individual may be normal and the intellect bright.

The forehead is usually quite prominent and there is a marked depression at the root of the nose, while the upper jaw is more or less prominent. The head is very large in comparison with the size of the face and may be mistaken for hydrocephalus.

There is marked micromelia or shortness of the extremities. The disturbance in the long bones is symmetrical; therefore, there is no unsightly deformity other than the lack of proper proportion in the height of the person. The spinal column is only slightly affected; therefore, the short stature

is due to the lack of the development of the femora. The humeri are also greatly affected so the arms will also be very short. The skin of the extremities will often be found to lie in deep folds.

Effect upon the spine:

Since the long bones are affected in a symmetrical manner there is no reason for the development of a lateral curvature of the spine, as in case of a short leg. The spine is not usually involved to any great extent, hence there is no particular abnormality there. The greatest change takes place in the lumbar region, where the anterior curve is exaggerated into a lordosis adaptative to the large abdomen.

## Rickets

Rickets can scarcely be spoken of as a disease of the bone, except for the reason that the greatest changes that take place are found to be those of the bones of the entire body. Medically, the etiology is unknown. According to the best authorities there are certain conditions which are known to contribute to the development of the disease, but the incoördination does not seem to be confined to any particular climate, set of conditions or class of people. It affects the children of no one class in particular, for it may be found among the rich and well fed as well as among the poorer classes of people, although, of course, improper hygienic conditions will favor the development of the disease as in any other abnormal condition which would decrease the intellectual adaptability of the body. It is generally conceded that poorly and improperly fed children are more prone to the disease, although it is also claimed that the disease may occur, and often does occur, in children who have the very best care and proper food.

No race of people is immune, yet some nationalities seem to suffer more frequently and severely than others. For example, the Negroes and Italians seem to be most susceptible when placed in the North, particularly in congested quarters in northern cities. It seems to be a peculiarity of these races rather than a peculiarity of diet and mode of living.

In congested centers of the cities, rickets may be considered a very common and universal incoördination, occurring



Fig. 106. Skeleton Showing a Case of Rickets.

in children whose diet is rich in animal fat and proteins. Although it is believed that rickets cannot be caused by improper diet in children who would not otherwise be affected by the disease, yet it has been found that a condition resembling rickets can be produced in animals by a diet deficient in calcium salts and the condition cannot be easily or quickly corrected simply by adding these salts to the diet. Likewise, rickets, as manifested in children, will not yield to proper diet alone. Breast feeding does not insure immunity from the disease. This proves the contention of Chiropractic that the main cause of disease is in the patient and not in his environment, for while improper feeding and poor hygienic conditions may aggravate and increase the degree of the incoördination, yet the abnormality may appear regardless of how perfect the food and diet may be.

About the first symptoms to appear are nocturnal restlessness and profuse sweating about the head, particularly during sleep. The restlessness is especially marked; the patient rolling and tossing a great deal, usually moving the head back and forth on the pillow to such an extent that in the majority of cases the absence of hair on the back of the head becomes quite an important feature in the diagnosis. As the sweating is so very profuse, this may account for the fact that the rhachitic child becomes very susceptible to colds, bronchitis, and bronchial pneumonia. Most of these symptoms may be present in a great many different incoördinations, and are in no way conclusive evidence of rickets, but when there is persistent perspiration about the head, it is wise to diligently watch for other symptoms of rickets.

A deformity of the head may appear very early in the disease; this deformity makes the head appear large for the balance of the body, and is due to a thickening of the cranial

bones, thus producing the square head, so typical of rickets. This square head is known as *caput quadratum*. There may also be numerous soft spots in the bones of the cranium, which, when pressed upon, give a parchment crackling feeling to the fingers. This condition is known as *cranial tabes*. This condition is also associated with syphilis, but it is not necessarily the result of syphilis in every case. The fontanel does not close until the third or fourth year and the sutures remain open for an abnormal length of time. The skin is usually very thin over the forehead and the veins are prominent owing to dilation. The large rhachitic head is often mistaken for a case of hydrocephalus. Usually, there is a deformity of the palate and the nasal passages, which interferes with respiration. The child is usually very slow in cutting the teeth, and when they do appear they are very likely to be more or less deformed.

The condition known as the beading of the ribs is practically always present and is known as the "rhachitic rosary." This consists of a series of nodules at the line of the junction of the costal cartilages with the ribs. However, these nodules, while very prominent in some cases, in other cases may not be visible externally. The chest is also deformed in such a way that the transverse diameter will be markedly decreased, while the antero-posterior diameter is increased. This gives rise to the typical pigeon breast. These deformities develop as a result of the softening of the bones of the thorax.

The most characteristic deformity of the spine in these rhachitic cases is a *kyphosis*, usually involving the lower dorsal and the entire lumbar region, although a lateral curvature may appear. In a well defined case of rickets every bone in the body is likely to be involved. A very fine specimen of rickets will be found in our Osteological Studio, consisting of

the entire skeleton, in which it is claimed there is not a single normal bone to be found.

The perfect diagnosis in rickets may be found by observing the changes that take place, particularly in the bones of the body; therefore a patient may be suffering from this disease, but the symptoms may not be recognized until great momentum has been attained. The most striking characteristic of the disease is, as has been said, the absence of calcium in the bones, which is due to the disturbances in metabolism, caused by some disorder of nutrition. Some authorities claim that this is because of a lack of calcium in the blood, but in view of the above statements on this phase of the subject this theory could not be accepted. Chiropractically, while the disease does often occur in children whose diet is deficient in calcium, it cannot be corrected by the most scientific diet which is rich in calcium. Because of the decrease of lime salts in the bones they become soft, and as a result there is a decided tendency towards curvature of the bones. There is a marked swelling in the epiphysis, and often enlargements are to be found, due to deposits from the bones. There is also a disturbance in the longitudinal growth of the bones, resulting in a dwarfed condition in adult life.

A case of rickets usually presents characteristic curvatures of the bones. The long bones, in particular, are as a rule involved symmetrically. This deformity is the result of the contraction of the muscles. In the arms these curvatures may be exaggerated when the child creeps, and in the legs they may be increased as the result of early walking, although genu varum or genu valgum may occur in children who have never walked. In these rhachitic cases the child may be very slow in learning to walk and this in many instances is the first intimation of the abnormality.

Fractures very often occur, and most particularly green stick fractures. The thickening of the epiphysis will always be present and will be most marked at the wrists and ankles. In severe cases the upper epiphysis of the tibia and fibula are invariably curved.

In practically all cases of rickets there is an arrested longitudinal growth in the bones to such a marked degree that the height will be very much less than that of the normal child. This condition is the result of the lack of the proper development of the lower extremities rather than a lack of development in the trunk of the body of the child, for, as a rule, the average length of the trunk is about normal, the arms and legs manifesting the incoördination by being very short. There is no particular pathology existing in the ligaments and muscles, although they will not be properly developed. The muscles are small and weak, making it difficult for the child to sit alone, to walk, or to hold up the head. The joints are also loose and weak because of the lack of the proper tonicity in the ligaments, a condition which results in what is known as double joints. The general M minus condition existing in the muscles may result in paralysis, but it is found that even though the muscles are very weak and flabby, the electrical reaction will be more or less exaggerated, while the reverse is true in paralysis. This general motor minus condition produces the characteristic enlargement of the abdomen, producing what is known as pot belly. This in turn results in digestive disturbances. Also the M minus condition decreases the vermicular motion in the intestinal tract, thus resulting in constipation. There may be marked anemia, particularly if there is an enlargement of the spleen, in which event the lymphatic glands will be found to be enlarged. There also may be leukocytosis. When this

condition prevails the patient is seldom emaciated but is usually inclined to be fat; the flesh, however, is very soft and the patient more or less weak.

The equation for this condition is motor function minus with possibly secretion minus; secondarily, a general motor minus condition will be found, with occasionally a local motor function plus, which accounts for the spontaneous fractures which often occur. The major will involve atlas and kidney place. Where the spleen is involved it will be necessary to always include spleen place

## Osteomalacia

Osteomalacia is an incoördination characterized by softening of the bones of the entire body. It so closely resembles rickets that there has been much dispute as to whether or not the two diseases are related. There are two forms; the juvenile form, which affects children, and the senile, which affects the aged. It is quite difficult to differentiate juvenile osteomalacia from rickets. In the adult, osteomalacia is often mistaken for sciatica or rheumatism. It often affects women during the reproductive age usually after they have borne children. However, the condition may be found in men. Medically, the etiology is uncertain.

Osteomalacia is considered an endemic disease; it is prevalent in certain areas and absent in others. Usually the first symptoms to appear are the pains in the back, the hips, and the extremities. Movement of the body will aggravate this pain. Walking is difficult and the patient fatigues easily. The difficulty experienced in walking is due somewhat to the pain but more largely to the weakness in the muscles which is called Osteomalacia Paresis. Adductor spasms of the thigh may also be present.

The softening of the bone is due to the absorption of the osteoblasts which are replaced with uncalicified osteoid tissue. There is great diminution of all mineral constituents of the bone. The bones being abnormally soft become deformed under the weight of the body. Sometimes they are so soft that they may be cut with a knife.

The bones of the thorax may become deformed, resulting in what is known as myocardial insufficiency. The pelvis in the female often becomes badly deformed which may interfere with parturition. The ends of the fingers may become flattened as the result of the patient endeavoring to support the weight of his body on rising from the sitting position. There may be feeble memory, indecision, and irritability which constitute the nervous and mental symptoms.

There is a question as to whether the condition is the result of some abnormality of the thyroid gland or of the ovary although it has been found that the condition will not yield satisfactorily to treatment for the thyroid gland. Some results have come from double oophorectomy (removal of both ovaries) but the cases have been so rare that a logical conclusion could not be reached from this observation. There is no question but Osteomalacia is a disturbance in the reparatory metabolism in the bones. It is possible that there is destructive metabolism wherein the mineral matter of the bones is destroyed, possibly by an abnormal secretion which acts on the calcium salts, due to an interference with transmission.

The duration of the disease may be of great length, especially in those cases which occur in adult life, particularly those that develop after pregnancy. The patient may be bed ridden for a considerable length of time.

The equation would be Reparation Minus with Nutrition Minus. The adjustment would be K. P., with P.P., and possibly S.P.

## Osteoporosis

Osteoporosis is a condition wherein the bones of the body lose much of their calcium and become more or less transparent. As this is often associated with an inactivity of the muscles of the part affected the condition is thought to be due to muscular atrophy and muscular inactivity. Muscular atrophy or muscular inactivity is always the result of interference with the transmission of mental impulses to the muscle tissue. Simply lack of motion in the muscles attached to the bones would not, in itself produce osteoporosis, therefore this pathological condition must be the result of the interference with transmission of mental impulses to the bones direct and as the muscles and the bones affected may be in the same meric zone the pressure upon the nerves will interfere with the transmission to the bones as well as to the muscle tissue.

Osteoporosis is not very common. It is sometimes associated with arthritis and also following the fracture of bones. It may also be found in connection with toxins in the body.

### Effect upon the Spine:

If the bones of the spine are involved, there will be curvatures as a result of the softening of the bones and their giving way under the weight of the trunk. If other parts of the body are affected causing deformity there may also be curvatures of the spine adaptative to these abnormalities.

## Osteitis Deformans

Osteitis Deformans or Paget's disease is a condition characterized by extreme pain in the bone and a marked deformity of the body due mainly to softening of the bones. When the bony tissue softens as the result of rarified Osteitis, it is called Osteoporosis, which is an enlargement of the spaces in the bone. As the symptoms usually appear after the fiftieth year, Osteitis Deformans is sometimes called Senile Pseudo-Rickets.

Medically the etiology is unknown. It is considered a family disease although it is not necessarily hereditary and is not necessarily associated with syphilis. It is often associated with Arterio Sclerosis in which there is hyperplasia of the outer layer of the arteries that are involved and degeneration of the elastic layer.

One of the first signs of the approaching condition is extreme pain in the bone. This pain may be mistaken for rheumatism or neuralgia and may precede the deformity by years. As the onset is insidious, the deformities may become quite marked before they are discovered. The bones may become abnormally curved and there is a development of bone tissue in the longitudinal direction on the convex side as an adaptation for the purpose of strengthening the bone. There is also thickening of the bones from the subperiosteal and medullary bone formation. The bones may become twice their normal size; they are not affected symmetrically. The skull may be the first to show the deformity. Later the tibia, femur, pelvic bone, spine, clavicle, ribs, and the radius are affected and become enlarged.

The head may become quite large resembling rickets or hydrocephalus. It is typically triangular shaped with base upward. The frontal bones project and the parietal bones resemble a rachitic head. However, the sutures are not sunken and the fontanelles are closed. In some cases the bones of the face become affected by the hypertrophy and as a result perfectly healthy teeth may be forced from the jaw. Usually the face is relatively small.

Although the legs become affected early in the disease the patient continues to walk. Much difficulty is experienced as the legs are curved forward and laterally and there is a tendency for one foot to stumble over the other. The height of the patient may be decidedly decreased due to the bowing of the legs and the other deformities of the body.

The clavicle is excessively curved and greatly enlarged. The lower aperture of the thorax is enlarged and the thorax may become flattened laterally. The thorax becomes cylindrical in shape and separated from the very prominent abdomen by a deep transverse depression. Respiration may be greatly interfered with through the deformity of the thorax; it may become entirely diaphragmatic. A posterior curvature may develop in the lower cervical and the upper dorsal region. The deformities of the thorax account for the cardiac and the bronchial symptoms.

When the deformities become quite marked the patient presents the characteristic appearance. This is produced by the cervico-thoracic kyphosis, the forward incline of the head, the bow legs, the cylindrical thorax, and the large abdomen.

## Spina Bifida

Spina Bifida is a congenital deformity in which the vertebral arches fail to unite in the posterior median line leaving the contents of the cord more or less exposed.

There may be only a very slight cleft in the spine in which there is no protrusion noticeable. This is known as Spina Bifida Occulta.

Whether the condition is Spina Bifida or Spina Bifida Occulta depends upon when the condition began in foetal life. If the process of development is arrested very early in foetal life then the division or separation of the lamina will be marked and there will be a protrusion of the canal contents but if the vertebral arches develop for a time and later, because of some interference with transmission, the development is arrested, there may be a mere cleft in the spine with no protrusion.

Usually the condition is due to early failure in development; the structures that should be developed between the cord and the skin remain undeveloped. When the deformity starts before the cord becomes segmented it remains adherent to the epiblastic layer from which it is developed, hence there will be found in the sac which protrudes all the structures, which should be separated in the natural processes of development such as filaments of the cord, nerves, and meninges.

If the process of development has been arrested at a later period, the contents of the canal will not be fused with the sac but may be merely attached to it; or in still less exaggerated cases the cord may not protrude at all into the sac,

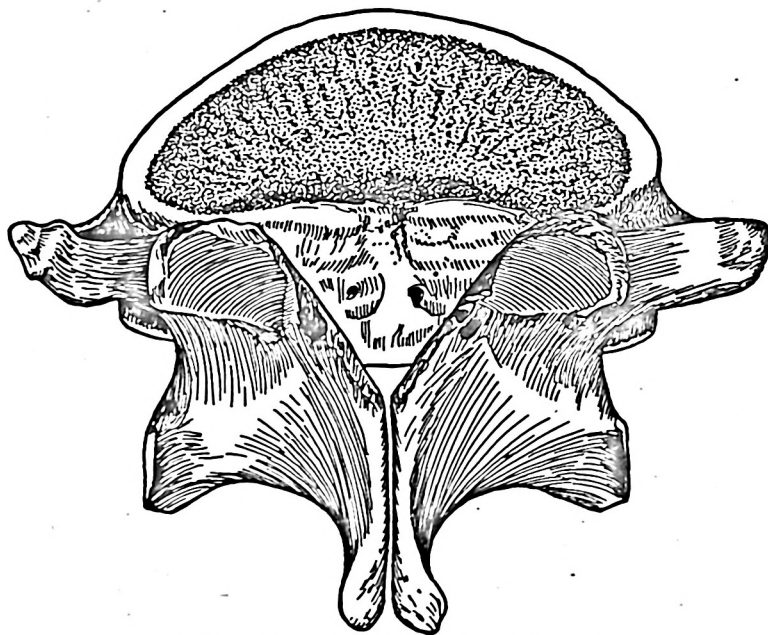
there being nothing but the meninges and the cerebro-spinal fluid; still in other cases, there may be no protrusion at all as in Spina Bifida Occulta.

The canal does not close at the same time in all regions of the spine; the upper cervical and lower lumbar regions are the last to be completed, therefore these regions form the most common site of Spina Bifida. Spina Bifida is usually easily recognized, although it is often difficult to distinguish one variety from another. These different varieties are:

1. Rachischisis (Syringomyelocoele)
2. Myelomeningocoele (Meningomyelocoele)
3. Meningocoele (Meningocoele)

In Rachischisis (Barker) "Syringomyelocoele" (Holt) the development of the neural arches has been arrested very early while the cord was still flat, the accumulation of fluid in the arachnoid space pushing the cord outward and the attenuated elements of the atrophied cord forming the lining of the sac. This is the most unusual and the worst form of Spina Bifida. It is most often associated with hydrocephalus. In such cases there is a direct communication between the tumor and the lateral ventricles of the brain so that pressure on the anterior fontanel will increase the size of the tumor and vice versa. These cases live only a few days and never more than a few months. There is nothing that can be done for them Chiropractically or any other way but it is well to be able to recognize such cases that we be not deceived in the prognosis.

Myelomeningocoele (Barker), Meningomyelocoele (Holt), is a condition wherein the cord is contained in the sac but the process of development not having been arrested so early the cord is more perfectly formed but is forced from



*Spinabifida of Fifth Lumbar Vertebra.*

Fig. 107. Spina Bifida.

the canal by the collection of fluid in the anterior subarachnoid space and is usually closely adherent to the posterior wall of the sac. It may be only partially covered by skin. There is often a vertical furrow corresponding to the attachment of the cord on the inner surface.

The Meningocele is a protrusion of the membranes only and the fluid is from the subarachnoid space posterior to the cord. It is larger than the myelomeningocele. The tumor may grow to an enormous size, being as great as six inches in diameter. The patient may live to adult life, as there is very seldom any paralysis with this condition. If the tumor is not too large and sensitive and the cleft in the spine is not too great, adjustments may be given and results obtained, but the prognosis is not the best.

#### **Spina Bifida Occulta.**

This is a condition that often goes undetected for there is no tumor present and the cleft in the spine is so very small that it may be difficult to detect from palpation. There may be sensory disturbances in the lower extremities or the patient may complain of some slight incoördination in the legs. There will be found an area of hypertrichosis, usually arranged in a crescent, with convexity downward, over the region of the spine where the cleft is located. If the muscles are not too heavy, the abnormality may be detected by vertebral palpation but if this does not reveal the condition it will be necessary to resort to the Spinograph. An X-Ray picture of the spine is advisable. This condition is found most often in the lumbar region and in adjusting them the adjustment is given on the laminae or mammillary processes. The prognosis is good, even tho the adjustments are not given until the patient has reached adult life. Of course, the processes

of reparation are much more rapid in early life. We have seen a case where the Spinograph showed Spina Bifida Occulta in the lumbar region of a woman of thirty years. She took a course of adjustments, after which the X-Ray plate showed that osseous tissue was being built and the cleft being filled in.

The equation for the malformation of the vertebral arches would be X-. The condition is usually due to cord pressure and the adjustment would be Atlas, Axis, or local.

**PART XII.**

**Muscles and their Relation to the Spine .**

**Ventral Muscles**

**Muscles of the Back**

## Muscles and their Relation to the Spine

In the preparation of the following chapter, the author has been actuated by the feeling that a study of the muscles that act upon the spine is essential to a complete course in Orthopedy. It is not our aim to teach the subject of Myology in all of its aspects. We shall include only those muscles that act upon the spine in a general way, giving in a general way the origin, action, and the insertion of the muscles so that the student may better understand the action of the muscles upon the spine. We shall deal with the question of nerve supply for a knowledge of nerve distribution will enable the student to find the causative subluxation in case of in-coördination in any of the muscles.

In the following treatise on muscles, the author has followed very closely the text book on Chiropractic Anatomy by Dr. Mabel H. Palmer and to this book the student is referred for a more complete study of the subject.

The ventral muscles which we will consider are as follows:

- (a) Sterno-Mastoid
- (b) Rectus Abdominis
- (c) Linea Alba
- (d) Scalenus Anticus
- (e) Scalenus Medius
- (f) Scalenus Posticus
- (g) Rectus Calitis Lateralis
- (h) Intertransversalis Anticus
- (i) External Abdominal Oblique
- (j) Internal Abdominal Oblique

## Ventral Muscles

Since the spinal column is the central shaft to which all the other parts of the body are attached either directly or indirectly it becomes obvious that the spinal column would be affected more or less by the change that might occur in the other parts of the body.

It has been shown how a short leg will influence the shape of the spinal column, also how other deformities may result in the deformity of the vertebral column. It is generally conceded that any incoördinate action of the muscles of the back may produce curvatures of the spine but it must also be remembered that incoördinate action of the abdominal muscles may also produce curvatures of the spine, even though these muscles are not attached to it directly.

The action of these muscles upon the spine takes place through their attachment to the thorax. As the dorsal vertebrae form a part of the thorax, any change in this region would exert an influence upon the spine.

The greatest mobility of the spine is above and below the thorax and any movement of the thoracic region of the spine is more or less a movement of the entire thorax. This is undoubtedly a wise provision for the protection of the thoracic viscera.

There is no one muscle that extends from the pelvis to the head, but the origin and insertion of the several muscles of the back so overlap that the action is that of a continuous muscle with the advantage of the supplemental action be-

tween the several muscles. From this arrangement it will be observed that the different movements of the spine are accomplished, not by the action of one muscle alone or by a set of muscles, but by the combined, coördinate action of all the muscles that are attached to that part of the spine in which the movement takes place. In exaggerated movements of the spine the abdominal muscles as well as the muscles of the back may be involved and even those of the lower extremities, especially when the equilibrium of the body is involved. If the spine is to be flexed in a certain direction, the muscles on that side will contract while the opposing muscle on the opposite side must relax. If subluxations exist which interfere with the transmission of motor mental impulses producing a relaxation of certain muscles, known as motor minus that part of the spine to which these muscles are attached, either directly or indirectly, will be drawn in the opposite direction as a result of the normal current of mental impulses in the opposing muscles on the opposite side.

Only a few muscles are attached to the anterior surface of the spinal column directly but the muscles of the thorax and abdomen have a certain action on the spine from the anterior. The muscular connection between the head and the pelvis at the anterior is by certain muscular attachments between the head and the thorax and the thorax and the pelvis. These muscles are the Sterno-Mastoid superior to the Thorax, and the Rectus Anticus, and Pyramidalis below the Thorax.

**Sterno-Mastoid. Fig. 108.**

The Sterno-Mastoid muscle is attached to the mastoid process of the temporal bone and the outer two-thirds of the superior curved line of the occipital bone and to the superior surface

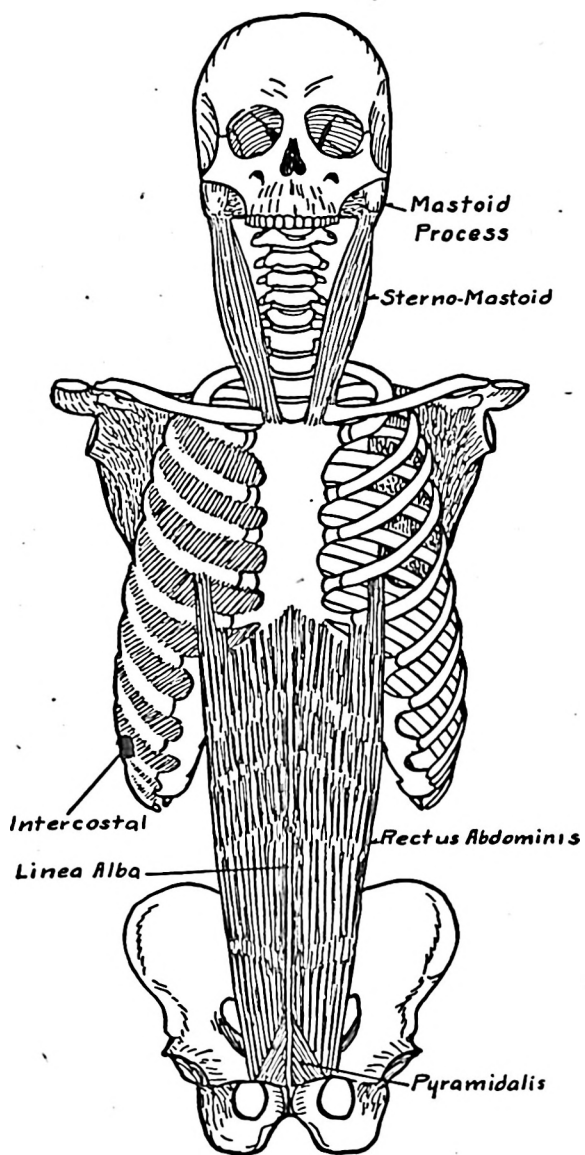


Fig. 108.

of the clavical at the medial ends. This is the origin while the mastoid process and superior curved line of the occipital bone forms the insertion. The specific action of this muscle is to rotate the head or when the muscles on both sides act at the same time the head is flexed in a forward direction, or if the action be on the sternum it will raise the sternum and clavical in extraordinary respiration. Contractures or motor plus conditions existing in this muscle on one side, will result in a rotation of the head and produce a condition known as wry neck or tortecollis, which will very likely result in a curvature in the cervical region.

The sternum is connected with the ribs and the ribs are joined together with ligaments and muscles so as to form a more or less solid connection between the sterno-mastoid muscles and the abdominal muscles below.

#### **Rectus Abdominis Muscle. Fig. 108.**

The Rectus Abdominis Muscle is a flat, strong ligament composed of longitudinal fibers which extend the entire length of the ventral portion of the abdominal wall. The region of this muscle is from the pubic crest and symphysis pubes. It increases in width as it extends upward where it is inserted into the costal cartilages of the fifth, the sixth, and the seventh ribs. The action of this pair of muscles is very important and varied. They assist very materially in all processes of expulsion; such as vomiting, defecation, micturation, parturition and labored expiration. These muscles help to support and compress the abdominal viscera.

When the two muscles act together they flex the spine and the pelvis. When the rectus abdominis muscle of one side only acts, the result is a lateral flexion of the spine and pelvis.

These two muscles receive their supply of mental impulses from nerves emitting from the fifth to the twelfth dorsal vertebra. A subluxation in this region produces pressure upon the anterior division of these nerves which reach these muscles and incoördination will result, the character of which depends upon the function that is involved.

**Linea Alba. Fig. 108.**

"The linea alba (white line) is a tendinous cord, extending from the ensiform cartilage to the symphysis pubes. It is a strong, dense, fibrous band, about one half inch broad at its upper part, above the umbilicus, but it becomes narrow below. It is formed by the decussation of the aponeurosis of the abdominal muscles of the opposite sides, except the Recti muscles, and this line serves to strengthen the wall." (Chiropractic Anatomy—Dr. M. H. Palmer)

**Pyramidalis Abdominus. Fig. 108.**

Attached to the linea alba is a small triangular muscle called the pyramidalis abdominis which arises from the crest of the pubes in front of the rectus abdominis muscle. It is inserted into the linea alba at the lower portion. The function of this muscle is to tense the linea alba.

### Oblique Muscles

Of the cervical muscles we are concerned in this subject only about those that are attached to the cervical vertebrae and influence the movements of the head and cervical region. The Obliquus muscles of the cervical region are attached in such a way that they assist in the various movements of this region. These muscles of the lateral cervical region are named as follows: Fig. 109.

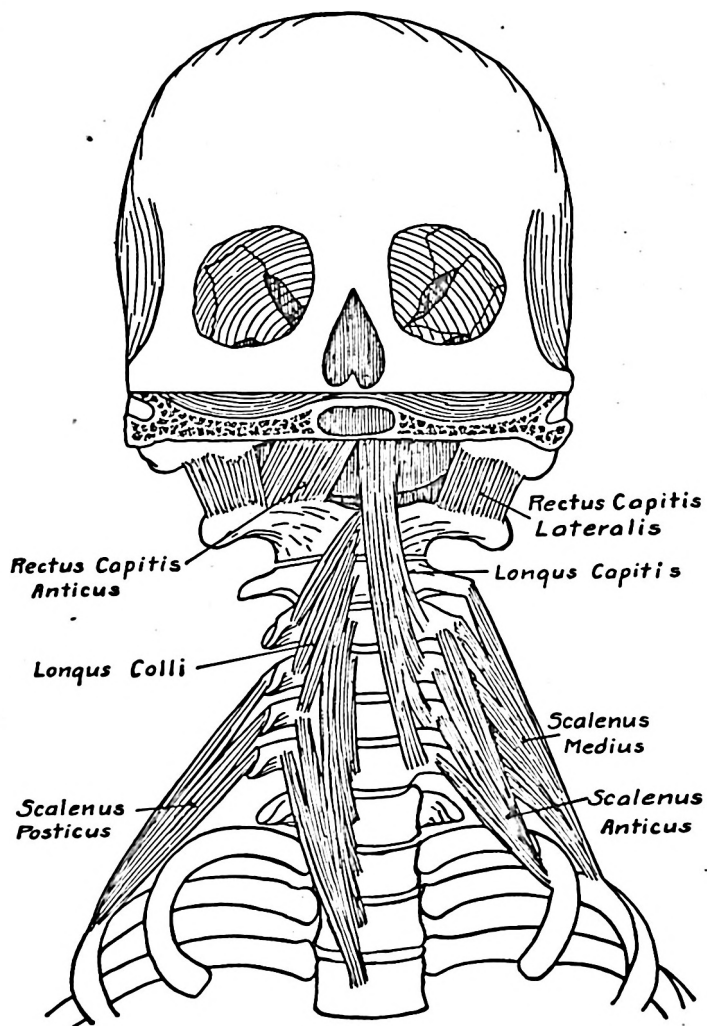


Fig. 109.

1. Scalenus Anticus
2. Scalenus Medius
3. Scalenus Posticus
4. Rectus Capitis Lateralis
5. Intertransversalis Anticus

### Scaleni Muscles.

These muscles are attached to the transverse processes of the cervical region from the axis to the sixth cervical inclusive. They are inserted into the first and second ribs.

#### Scalenus Anticus.

The Scalenus Anticus muscle is a flat muscle that is attached to the anterior tubercle of the transverse processes of the cervical vertebrae from the third to the sixth inclusive. This attachment is by means of four tendinous slips which pass to these four transverse processes. From this attachment it extends towards the inferior and the anterior where it is inserted into the scalene tubercle on the superior surface of the first rib.

This division of the scaleni muscles receives its supply of mental impulses through the nerves that emit through the fourth, the fifth and the sixth intervertebral foramina. When the two muscles, the one on the right and the one on the left, work together the head and neck will be bent forward; if only one acts, the neck will be bent forward and rotated in the opposite direction from the muscle that is acting. These muscles also assist in lateral flexion of the cervical region.

#### Scalenus Medius.

The Scalenus Medius is found just posterior to the scalenus anticus. It is a little broader than the scalenus anticus. It arises by six or seven tendinous slips from the anterior tubercle on the transverse processes of as many of the cervical vertebrae. From here it extends downward and

outward where it is inserted into the rough upper surface of the first rib just back of the subclavian groove and just behind the scalenus anticus.

This muscle is supplied with mental impulses through branches from the anterior division of the cervical nerves.

The action of this muscle on the spine is much the same as that of the scalenus anticus, especially in bending the neck laterally.

#### **Scalenus Posticus.**

The Scalenus Posticus muscle is the shortest of the three scaleni muscles and is located just posterior to the scalenus medius. It arises by two or three tendinous slips which are attached to the transverse processes of the sixth and the seventh or sometimes the fifth, the sixth and the seventh cervical vertebrae. This muscle passes downward and laterally and is inserted into the anterior border of the second rib.

This muscle receives its supply of mental impulses through the anterior division of the last two cervical and first dorsal nerves. The action of the scalenus posticus is similar to that of the scalenus anticus and medius.

The three Scaleni muscles are important to the Chiropractor because of their action upon the cervical region. Their combined action serves to flex the neck laterally, to rotate the head and neck and when the muscles of both sides act together to flex the neck forward. When they act from the opposite direction they assist in raising the ribs and thus assist in inspiration.

#### **Rectus Capitis Lateralis.**

The Rectus Capitis Lateralis is a flat muscle consisting of short fibers extending from the transverse processes of

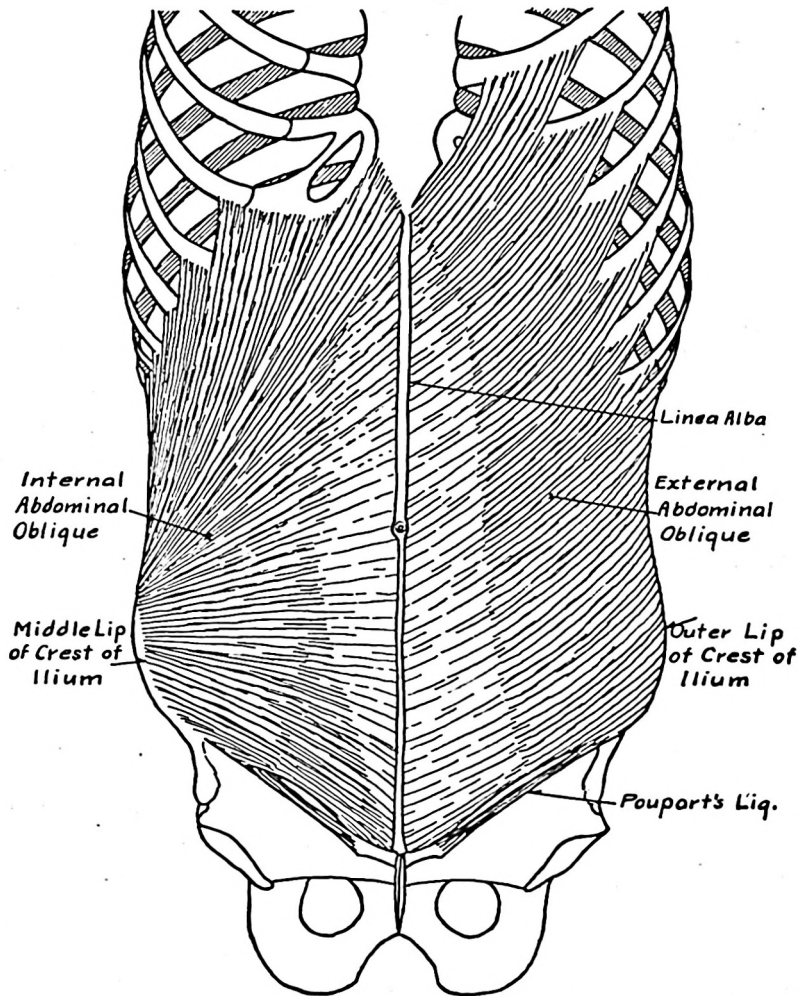


Fig. 110.

the atlas to the superior surface of the jugular process of the occipital bone. This short muscle receives its mental impulses through fibers of the first pair of nerves. The action is to bend the head laterally and to rotate the head.

#### **Intertransversarii Muscles.**

We might mention here the intertransversarii muscles which are a series of slender muscles extending between the transverse processes. In the cervical region there are two divisions, one attached to the anterior root and one to the posterior root of the transverse processes. The anterior branch of the spinal nerves pass between these two slips.

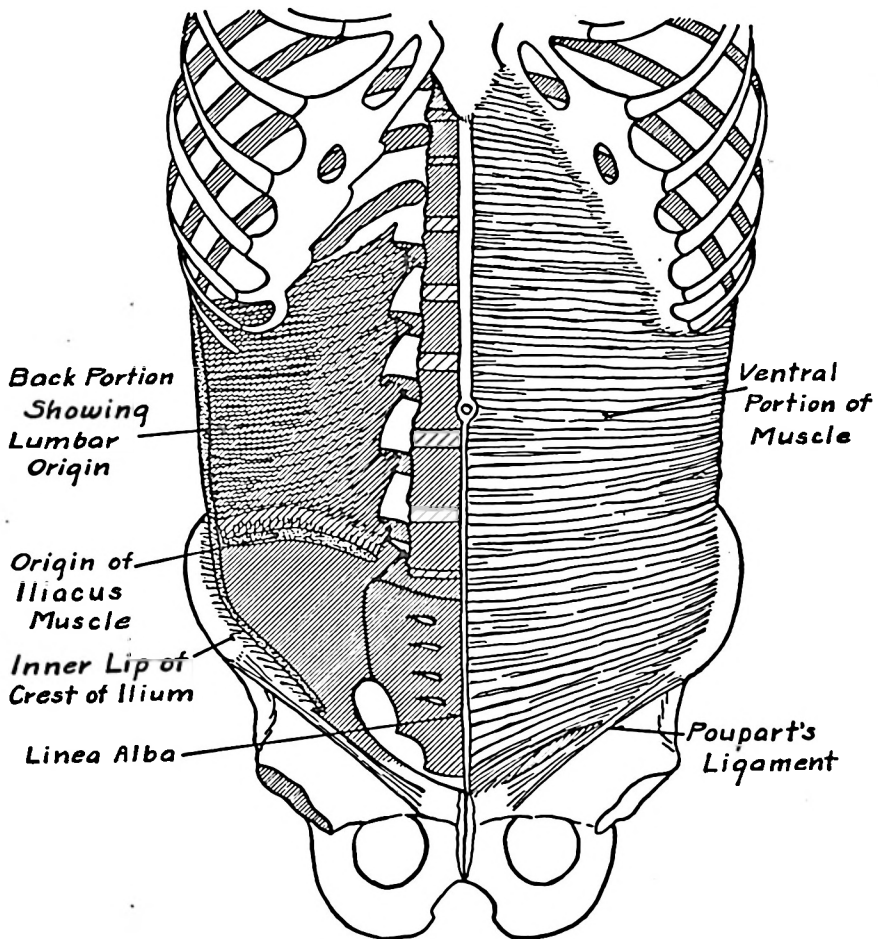
These muscles assist in the lateral movement and in the rotation of the cervical region. They receive their supply of mental impulses through nerves from the anterior rami of the cervical nerves.

#### **External Abdominal Oblique. Fig. 110.**

The external abdominal oblique, also called the Descending Oblique, is a thin muscular sheet, the fibers of which pass obliquely downward and forward covering the lateral anterior portion of the abdomen. It is the largest of the abdominal muscles and should be considered in connection with the spine because of the action upon the thorax, spine and pelvis.

This large muscle has its origin from the lower eight ribs by means of as many fleshy finger like slips. From this origin the fibers pass obliquely downward and forward and are inserted into the outer lip of the crest of the ilium and by means of an aponeurosis into the ensiform cartilage, linea alba and the crest of the pubes.

The action of this muscle is to assist in compressing the abdominal viscera and it is also a muscle of expulsion. Acting



*Transversalis Abdominis  
Muscle*

Fig. 111.

from its origin it will flex the pelvis upon the thorax and rotate it in the direction of the muscle that is acting. Acting from the insertion it will flex the thorax and spine upon the pelvis and the accompanying rotation of the thorax and the spine will be in the opposite direction. If the obliquus externus on the left side acts from its origin, the pelvis will be flexed upon the thorax and slightly rotated toward the left. If the muscle on the left side acts from its insertion, the thorax and spine will be flexed upon the pelvis and slightly rotated toward the right.

From this action it can readily be seen what effect this muscle has upon the spine and how it might be responsible for certain curvatures of the spine.

The external abdominal oblique receives its mental impulses through the anterior division of the lower five or six thoracic nerves.

#### Internal Abdominal Oblique. Fig. 110.

The internal abdominal oblique muscle, also called the Ascending Abdominal Oblique, is a thin broad muscle directly beneath the external abdominal oblique. It is attached to the lumbar vertebrae by means of the dorso-lumbar fascia. Below it is attached to the lower half of Poupart's Ligament, which extends from the anterior superior spine of the ilium to the tubercle of the pubis.

The muscle is also attached to the anterior two-thirds of the crest of the ilium.

The internal abdominal oblique passes upward and forward from this broad origin and is inserted into the lower six ribs, the ensiform cartilage, linea alba and by the conjoined tendon into the crest of the pubis.

The action of this muscle is similar to that of the external abdominal oblique; it compresses abdominal viscera, draws the lower ribs downward and assists in flexing the thorax or pelvis laterally, depending upon the fixed point from which it acts. It will flex the thorax and spinal column on the pelvis or the pelvis on the thorax. As this flexion takes place there will be an accompanying rotation which will be just opposite to that of the external oblique. The thorax and the spine will be rotated toward the muscle that is acting and the pelvis will be rotated in the opposite direction. To illustrate: If the obliquus internus of the right side is producing a rotating action upon the thorax and the spine they will be rotated toward the right, but if the rotating force is acting upon the pelvis, the pelvis will be rotated toward the left.

Mental impulses are carried to the internal abdominal oblique muscle through the anterior division of the nerves that emit through the lower five or six dorsal intervertebral foramina.

#### **Quadratus Lumborum. Fig. 112.**

The quadratus lumborum muscle is found at the back portion of the abdominal wall. It is a flat quadrilateral shaped muscle which arises from the crest of the ilium and the ilio lumbar ligament and is inserted into the lower border of the twelfth rib and the transverse processes of the lumbar vertebrae.

The action of this muscle is to flex the lumbar region laterally to draw the last rib downward and to assist in forced respiration. With the lumbar region acting as the fixed point there would be a tendency to elevate the ilium. This muscle is supplied with mental impulses through the nerves emitting from the lower dorsal and upper lumbar region.

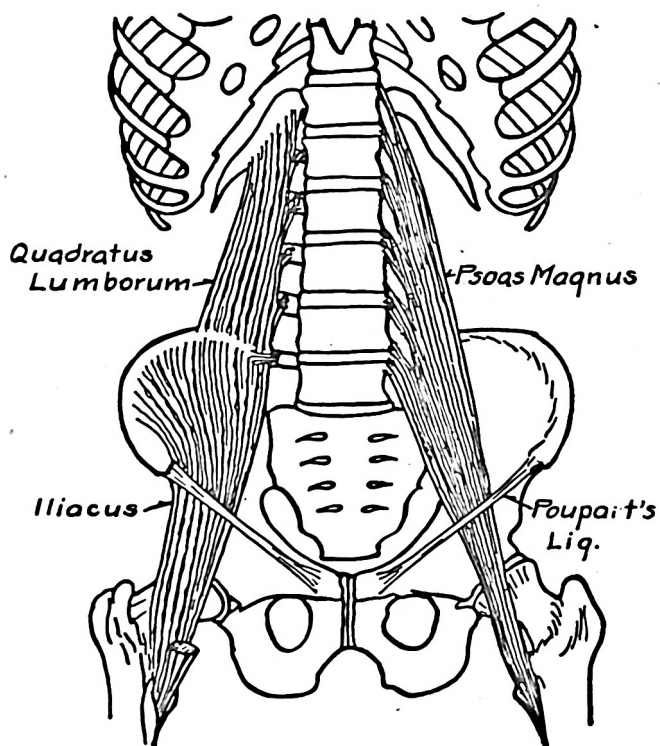


Fig. 112.

**Psoas Magnus. Fig. 112.**

The psoas magnus is a powerful muscle found on the posterior wall of the abdomen. It has a very extensive origin, arising from the intervertebral discs in the lumbar region and the bodies of the vertebrae from the twelfth dorsal to the fifth lumbar and from the transverse processes of all the lumbar vertebrae. The fibers converge as they pass downward passing beneath Poupart's ligament. The muscle is inserted by a tendon into the lesser trochanter of the femur. There is a bursa between the muscle and the pubes and the capsule of the hip joint.

The action of this muscle is to flex the spine laterally and to flex the body and pelvis upon the femur and vice versa. It is also the "stooping muscle," therefore, it is used in walking, climbing stairs, etc. It can readily be seen how a violent action of this muscle acting from its insertion might produce a subluxation in the lumbar region.

The mental impulses are transmitted to this muscle through the nerves superior to the second, third and fourth lumbar vertebrae.

**Iliacus Muscle. Fig. 112.**

The iliacus is a flat fan shaped muscle found in the iliac fossa. Its origin is from the margin of the iliac fossa, inner margin of the crest of the ilium, ilio-lumbar ligament, the anterior sacro-iliac ligament. It passes downward, the fibers converging to be inserted into the lesser trochanter of the femur.

The action is to flex the pelvis on the thigh and vice versa, and to give assistance to the psoas magnus muscle in its action.

The iliacus muscle receives its supply of mental impulses through the nerves that emit superior to the second, third and fourth lumbar vertebrae.

## The Muscles of the Back

The muscles of the back are divided into layers. Some authors mention five layers; others seven. For our consideration we will give the division into five layers according to Dr. M. H. Palmer.

### First Layer:

Trapezius.

Latissimus Dorsi.

### Fig. 113.

The Trapezius Muscle is a triangular shaped muscle located in the upper portion of the back and is divided into sets of fibers according to their attachment in the different parts of the back. This muscle arises from the medial one-third of the superior curved line of the occipital bone, the ligamentum nuchae, the spinous process of the seventh cervical vertebra, the spinous processes of all the dorsal vertebra and the supra spinous ligament from the seventh cervical to the twelfth dorsal vertebra.

That part of the muscle which arises from the occipital bone and the upper cervical region is inserted into the lateral one-third of the posterior superior surface of the clavicle. Those fibers which are attached to the lower cervical and the dorsal vertebrae are inserted into the inner border of the acromion process and the superior border of the spine of the scapula.

The action of this muscle depends upon whether the action is from the origin or the insertion and also whether

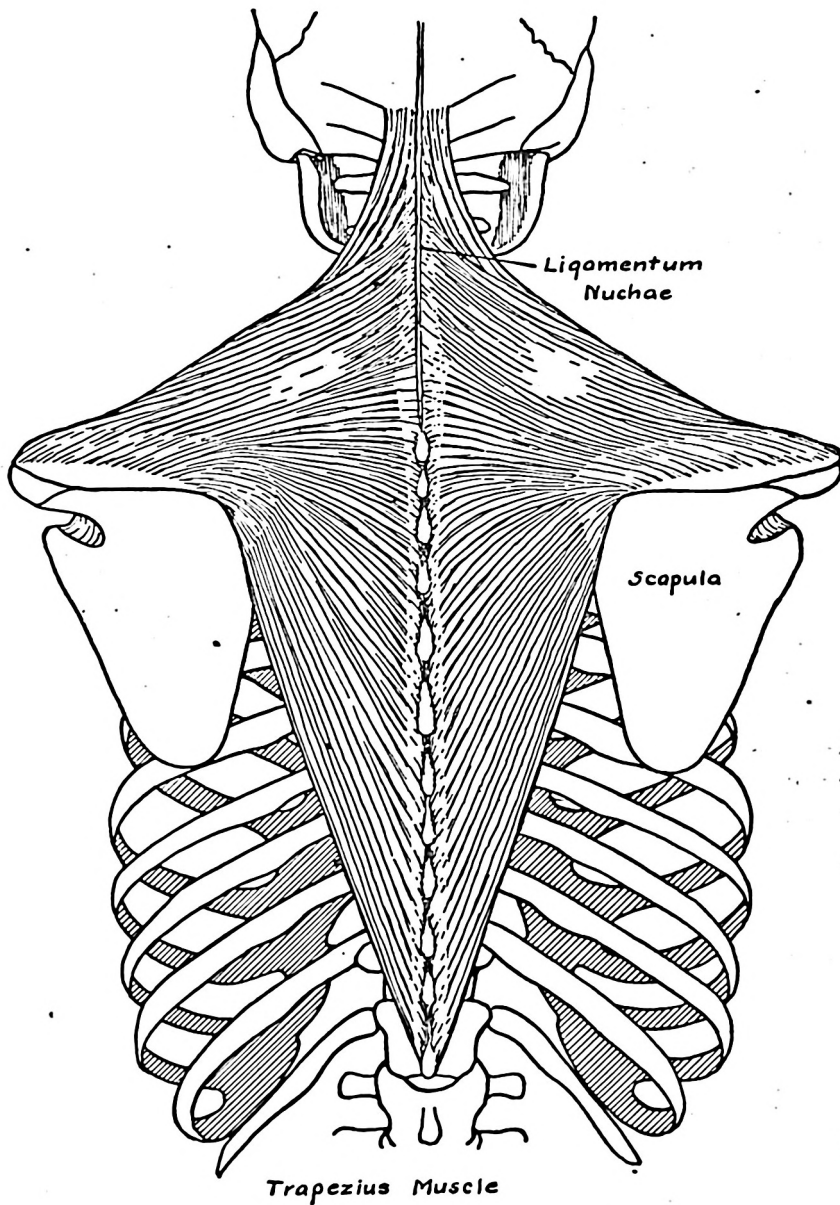


Fig. 113.

one or both muscles are acting. Acting from its superior origin, it will elevate the point of the shoulder. Acting from the balance of the origin, the shoulders are braced backward and the scapulae are retracted. Both muscles acting together will draw the head backward. If the action is from the insertion, the shoulder being the fixed point, the action will be upon the spinous processes to which that part of the muscle is attached in which the action is taking place and the tendency will be toward rotation of the spinous processes in the direction of the acting muscle.

**Latissimus Dorsi. Fig. 114.**

The latissimus dorsi muscle is a large triangular shaped muscle located in the lower portion of the back. Its origin is from three parts. The major portion of the muscle arises from the spinous processes of the lower six dorsal vertebrae and the spinous processes of the lumbar vertebrae by means of the posterior layer of the lumbo-dorsal fascia. By means of this fascia it is also attached to the tendon of the sacrospinalis, with which the lumbo-sacral fascia blends. This muscle also arises from the external lip of the crest of the ilium.

As it extends upward from this general origin to the inferior angle of the scapula its fibers converge. Slips also arise from the lower three or four ribs and join the muscle as it passes over the inferior angle of the scapula. From here on the muscle becomes quite narrow and curves around the teres major, ending in a narrow, thin tendon which is inserted into the bicipital groove of the humerus.

In the lower part of the back this muscle is superficial while in the upper part it is concealed beneath the trapezius.

The latissimus dorsi muscle acting from its origin moves

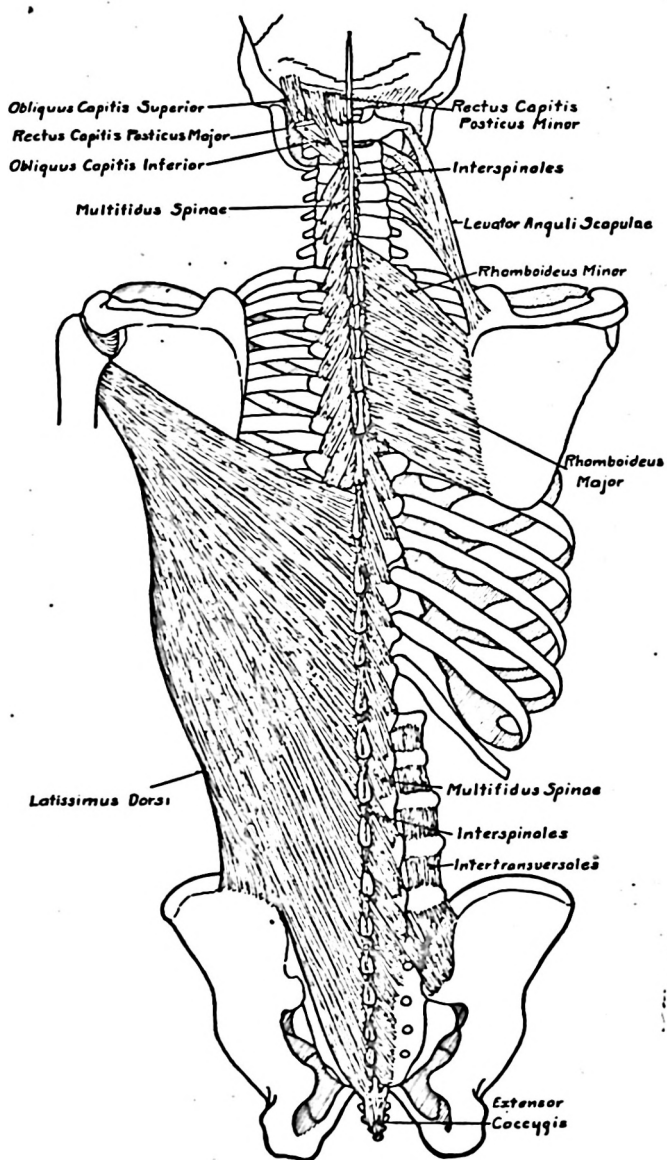


Fig. 114.

the humerus downward, backward and inward. Since the origin of this muscle is from the lower dorsal and lumbar spinous processes, the tubercular ridge of the sacrum, the crest of the ilium, the lower three or four ribs and the spine of the scapula, the action from the insertion would be upon these parts. It elevates the ribs, raises the pelvis, and also assists in forced respiration. In acting from its insertion without coordinate action on the part of the other opposing muscles, it might produce a subluxation of any of the lower six dorsal or the lumbar vertebrae. An extreme contracture of this muscle might result in a rotation of the spinous processes of the lower dorsal and lumbar region in the direction of the contracted muscle.

The latissimus dorsi receives its mental impulses through the long scapular nerve which arises from the posterior cord of the brachial plexus. The fibers of this nerve pass out from the spinal cord superior to the first and second dorsal vertebrae.

Second Layer: Fig. 114.

Levator Anguli Scapulae.

Rhomboideus Major.

Rhomboideus Minor.

#### Levator Scapulae.

The levator scapulae has a tendinous origin from the tubercle on the posterior root of the transverse processes of the atlas, the axis, the third and the fourth cervical vertebrae. It is a flat, "strap like" muscle which extends down the lateral side of the neck and is inserted into the posterior superior border of the scapula from the superior angle to the spine.

The upper portion is concealed beneath the sterno-mastoid muscle while the lower part is covered by the trapezius.

The levator scapulae receives its supply of mental impulses from branches of the cervical plexus which emit superior to the fifth cervical.

Incoördination in this muscle would be relieved by adjusting the fifth cervical vertebra. With the scapula as the fixed point, the action will be to flex the cervical region laterally and to rotate it in the opposite direction from the muscle that is in action.

#### Rhomboid Muscles.

The Rhomboid muscles are divided into the Rhomboideus Major and the Rhomboideus Minor. The Rhomboideus Major arises from the spinous processes of the second dorsal vertebra to the fifth dorsal vertebra inclusive. The Rhomboideus Minor, is in reality, merely a separate slip of the major portion of the muscle and it arises from the ligamentum nuchae and the spinous processes of the seventh cervical and the first dorsal vertebrae. They are both inserted into the vertebral border of the scapula. The Rhomboid Minor is attached to the root of the spine of the scapula just inferior to the insertion of the levator scapulae muscle, while the Rhomboideus Minor is inserted beneath the Rhomboideus minor between the root of the spine of the scapula and the inferior angle by a tendon. Only the inferior fibers are inserted directly.

The rhomboid muscles are quadrilateral in shape and pass downward and laterally from their origin to their insertion and they are practically concealed by the trapezius muscle. These muscles receive their mental impulses through nerves from the cervical plexus which have their exit in the lower cervical region.

The origin of these muscles being so extensive and the

insertion so narrow, it can be seen that they have no great action on the spine. Yet it is possible to have incoordinate action taking place in some part of the muscle. A violent contraction in which the scapula acts as the fixed point might result in a subluxation of the vertebrae to which the contracting part of the muscle was attached. In such event the spinous process of the vertebrae would be rotated toward the muscle that was acting and the bodies would be rotated in the opposite direction.

Third Layer: Fig. 115.

Serratus Posticus Superior.

Serratus Posticus Inferior.

Splenius Capitis.

Splenius Colli.

#### **Serratus Posticus Superior.**

The serratus posticus superior muscle is attached to the ligamentum nuchae, the spinous process of the seventh cervical vertebra, the spinous processes of the first, the second, and the third dorsal vertebrae and to the intervening supra spinous ligament.

It passes obliquely downward and laterally to the second, the third, the fourth and the fifth ribs where it is inserted into each by separate slips.

This muscle assists in respiration and elevates the ribs. It is an extensor of the spine and assists in lateral movements. A hypertonicity of this muscle on one side of the spine would result in a lateral bending of the spine in the direction of the muscle expressing the motor plus, while a lack of proper tonicity would result in a scoliosis in the opposite direction.

Incoordination in this muscle would be caused by inter-

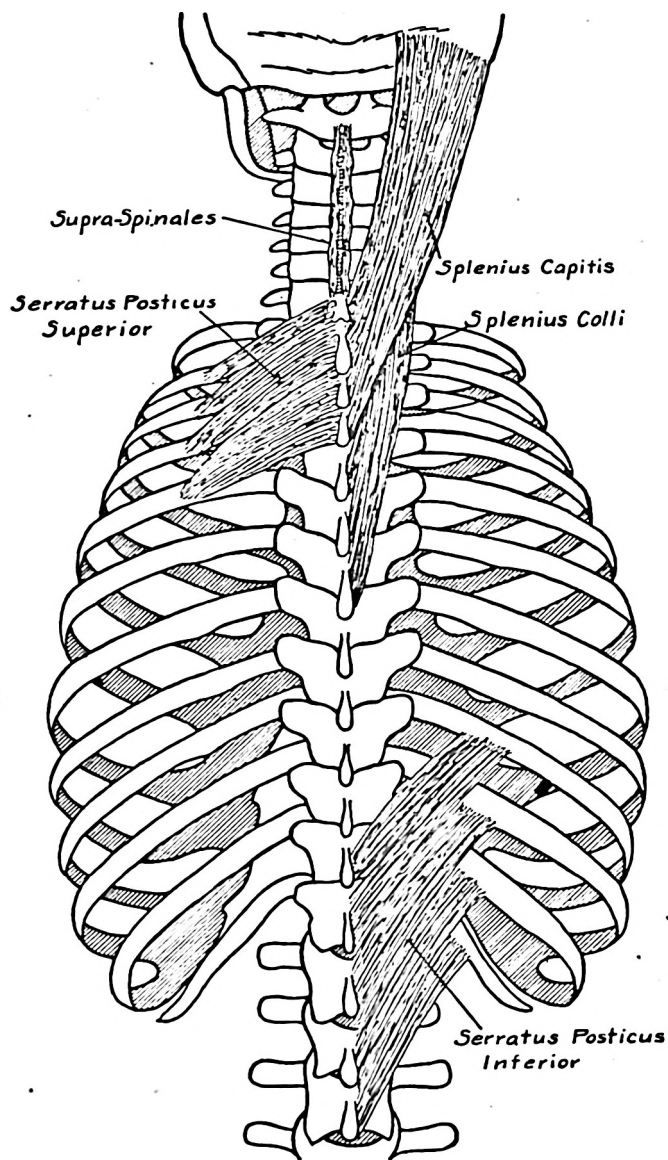


Fig. 115.

ference with transmission in the lower cervical or upper dorsal regions.

#### **Serratus Posticus Inferior.-**

The origin of the serratus posticus inferior muscle is from the spinous processes of the eleventh and the twelfth dorsal vertebrae and the first, the second, and the third lumbar vertebrae. These bands of fibers pass horizontally to the outer surface of the ninth, the tenth, the eleventh and twelfth ribs where they are inserted.

The action of this muscle is to draw the last four ribs downward and outward. It is used in inspiration. Acting on the spine from its costal insertion, it would assist in lateral movements of that part of the spine to which it is attached. With an incoordination of motor function plus the spinous processes to which this muscle is attached would be rotated in the direction of the muscle in which the action was taking place.

This muscle receives its mental impulses through nerve fibers that emit from the lower dorsal region, from about the ninth to the twelfth.

#### **Splenius Capitis and Colli.**

The splenius muscle is a broad flattened muscle with its origin from the lower one half of the ligamentum nuchae, the spinous process of the seventh cervical vertebra and the spinous processes of the lower six dorsal vertebrae. It is located in the lower part of the back of the neck and the upper dorsal region.

As the muscle passes upward and laterally into the side of the neck, the fibers divide into two parts, a superior and an inferior part. The superior portion is inserted into the

mastoid process of the temporal bone and to the outer portion of the superior curved line of the occipital bone. This portion of the muscle is called the Splenius Capitis.

The inferior portion is curved around the outer edge of the superior portion and is inserted into the tubercle on the posterior root of the transverse processes of the atlas, the axis and the third cervical vertebra. This part of the muscle is called the Splenius Colli.

The action of the splenius muscles is very important. The Splenius Capitis acting from its origin pulls the head backward and rotates it toward the side of the muscle in action; it also assists in lateral bending of the head. The action of the Splenius Colli (cervicis) is to rotate the atlas and to draw the upper cervical vertebrae towards the posterior.

These muscles receive their supply of mental impulses through the nerves that emit from the spinal cord in the lower cervical and upper dorsal region.

It can readily be seen from the origin and insertion of this muscle that incoordinate action in them would result in the drawing backwards of the head or a rotating of the head or upper cervical region. While a contracted condition or a contraction of the splenius muscles on both sides at the same time and of equal tonicity would result in drawing the head straight backwards.

A subluxation in the lower cervical or upper dorsal region impinging the nerve fibers that supply these muscles would cause incoordination and result in an abnormal posture of the head. A violent contraction, especially of the splenius colli might result in a subluxation of the atlas or one of the upper cervical vertebrae.

**Fourth Layer. Fig. 116.**

Erector Spinae.

· Ilio-costalis.

Ilio-costalis Lumborum.

Ilio-costalis Dorsi (Musculo Accessorius).

Ilio-costalis Cervicis (Cervicalis Ascendens).

Longissimus Dorsi.

Transversalis Colli (Longissimus Cervicis).

Trachelo-Mastoid (Longissimus Capitis).

Spinalis Dorsi.

Spinalis Colli.

Complexus.

Biventer Cervicis.

**Erector Spinae.**

The erector spinae muscle, also called the Sacro-spinalis, is a large muscle extending upward from the sacrum and ilii to the head. It is divided on its way upward into ten parts each, named according to the insertion or parts to which it is attached.

In its lower portion it occupies the sacro-iliac groove and the vertebral groove in the lumbar region.

This muscle originates by strips of fibers from the crest of the ilium, posterior sacro-iliac ligament, the side of the posterior surface of the sacrum, and is attached to the rudimentary spinous processes of the sacrum, spinous processes of the lumbar vertebrae and the eleventh and twelfth dorsal vertebrae. From this broad origin the ligament divides into separate slips which are named and inserted as follows:

The ILIO-COSTALIS is the most lateral division of the erector spinae and extends upward from that part of the muscle which arises from the crest of the ilium. It is divided

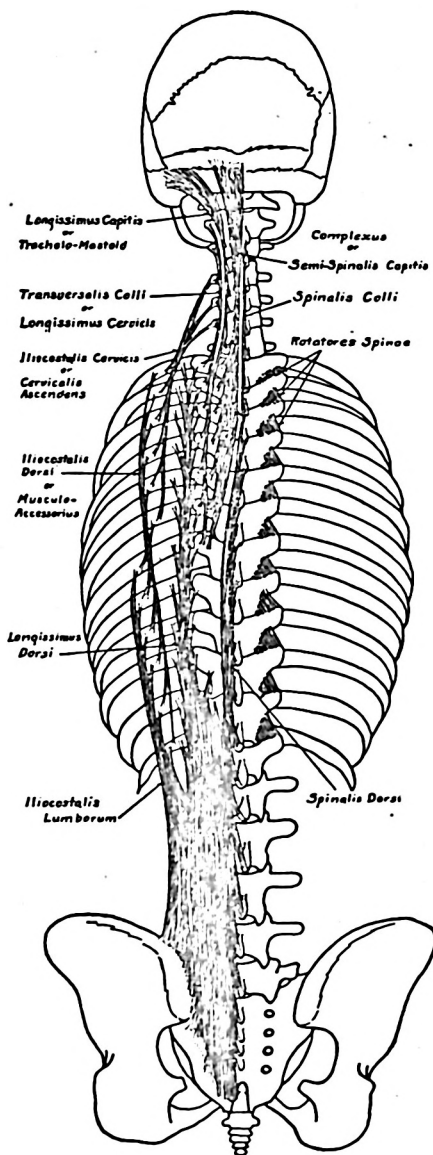


Fig. 116.

into three parts: The Ilio-costalis Lumborum, the Ilio-costalis Dorsi and the Ilio-costalis Cervicis.

The ILIO-COSTALIS LUMBORUM is the most lateral division of the muscles and is inserted into the lower six ribs by slender slips.

The ILIO-COSTALIS DORSI, also called the Musculo Accessorius, begins at the lower six ribs by slender slips near, and just medially to, the insertion of the ilio-costalis lumborum and extends upward as a narrow muscle to be inserted into the angle of the upper six ribs by fleshy slips. Arising near this insertion and just medially will be found the beginning of the third division called the ilio-costalis cervicis.

The ILIO-COSTALIS CERVICIS, also called the Cervicalis Ascendens. This division arises by six slips from the upper six ribs and is inserted into the transverse processes of the fourth, the fifth, and the sixth cervical vertebrae.

The LONGISSIMUS DORSI is the largest division of the Erector Spinae muscle; is the extension upward of the medial portion of this muscle. It is inserted into the transverse and accessory processes of the lumbar vertebrae and the transverse processes of the dorsal vertebrae, medially, while laterally it is inserted into the ribs just lateral to the tubercles.

The TRANSVERSALIS COLLI, also called the Longissimus Cervicis, represents the continuation of the longissimus dorsi. It continues upward from the transverse processes of the upper six dorsal vertebrae and is inserted into the transverse processes from the axis to the sixth cervical vertebra.

The TRACHELO-MASTOID, also called the Longissimus Capitis, is really a continuation of the Transversalis Colli. It extends upward from the transverse processes of the upper dorsal vertebrae and the articular processes of the

lower cervical vertebrae, and is inserted into the mastoid process of the temporal bone.

The transversalis colli and the trachelo-mastoid together with the longissimus dorsi form the middle portion of the erector spinae. These three divisions forming the larger part of the muscle.

The SPINALIS DORSI. The medial portion, or that part of the erector spinae nearest the medial line of the back is called the spinalis dorsi. It extends from the spinous processes of the first and second lumbar vertebrae and the eleventh and twelfth dorsal vertebrae upward and is inserted into the spinous processes of the dorsal vertebrae from the fourth to the eighth inclusive.

The SPINALIS COLLI extends upward from the spinous processes of the first and second dorsal vertebrae and the sixth and seventh cervical vertebrae and is inserted into the spinous processes of the axis, the third and fourth cervical vertebrae.

The COMPLEXUS, also called the Semispinalis Capitus, is the continuation upward of the Spinalis Colli of the erector spinae. This division of the muscle begins at the transverse processes of the upper six dorsal vertebrae and the articular processes of the fourth, the fifth, the sixth and the seventh cervical vertebrae. It is a broad, flat muscular band, which extends upward and is inserted between the superior and inferior curved lines of the occipital bone. The Biventer Cervicis is usually blended with the Complexus.

#### Action of the Erector Spinae.

The action of the Erector Spinae is varied and of great importance. The muscle as a whole helps to keep the spine in the erect position. It assists in lateral movements of the spine and in rotation. It steadies the head and in walking

practically the entire muscle is brought into use, assisting especially in the extension and lateral movements of the pelvis.

It will be necessary for the student to study the specific action of the several divisions of this great muscle in order to appreciate its importance and the powerful influence which it exerts on the spinal column.

First let us consider the action of that portion of the muscle which is called the Ilio-Costalis; the action of this part of the muscle is to bend the spine backward in the lower cervical, dorsal and lumbar regions and also to produce side bending of the trunk. A motor plus condition in the Ilio-Costalis muscle of one side of the back would produce a scoliosis with the convexity towards the affected muscle. A motor minus in this muscle on one side of the back would result in a scoliosis with the concavity toward the side of the affected muscle.

Second. The Longissimus Dorsi and Transversalis Colli will act very similar to the Ilio-Costalis muscles except that the action may be as high as the axis. The Trachelo-Mastoid, or Longissimus Capitis, will act upon the head, drawing it backward when the muscles of both sides act in unison with each other, but when only one of these muscles act the result will be a rotation of the head in the direction of the muscle that is in action.

Third. The Spinalis Dorsi, Spinalis Colli and the Complexus act as great extensors of the spinal column.

#### Fifth Layer.

Semi-spinalis Dorsi.

Semi-spinalis Colli.

Multifidus Spinae.

Rotatores Spinae.

Supra-spinales.  
Inter-spinales.  
Extensor Coccygeus.  
Inter-transversalis.  
Rectus Capitis Posticus Major.  
Rectus Capitis Posticus Minor.  
Obliquus Capitis Inferior.  
Obliquus Capitis Superior.

**Semi-spinalis Dorsi. Fig. 117.**

The Semi-spinalis muscle is arbitrarily divided into two divisions, a superior and an inferior division. These divisions are named according to the parts to which they are attached.

The Semi-spinalis Dorsi arises from the transverse processes of the dorsal vertebrae from the sixth to the tenth inclusive, and is inserted into the spinous processes of the sixth and the seventh cervical vertebrae and the first four dorsal vertebrae.

The Semi-spinalis Colli arises from the transverse processes of the first five or six dorsal vertebrae and is inserted into the spinous processes of the cervical vertebrae from the axis to the fifth inclusive.

The action of the Semi-spinalis muscles is to extend the spine and to flex it laterally. It also helps to hold the spine erect.

**Multifidus Spinae. Fig. 114.**

The Multifidus Spinae muscle is a slender muscle which extends from the sacrum to the axis. The origin and the insertion being along the entire course of the muscle.

The origin is from the posterior surface of the sacrum, the posterior superior spine of the ilium, the inner lip of the

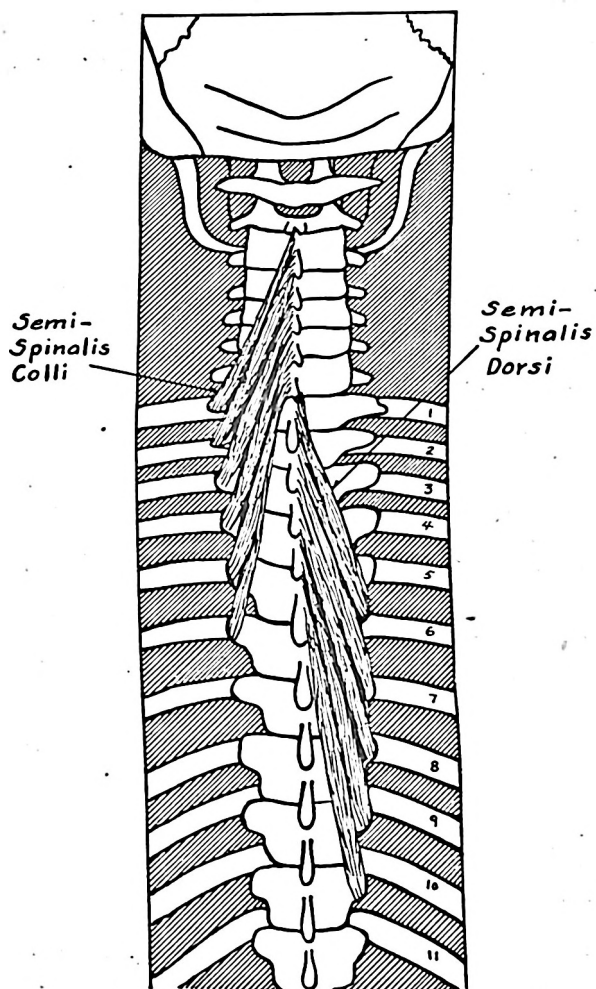


Fig. 117.

crest of the ilium the sacro-iliac ligament. In the lumbar region the origin is from the mammillary processes; in the dorsal region from the transverse processes and in the cervical region from the articular processes of the fourth, the fifth, the sixth, and the seventh cervical vertebrae.

The insertion is into the spinous processes of all the vertebrae from the fifth lumbar vertebrae to the spinous process of the axis.

This muscle lies in the vertebral groove between the spinous processes of the vertebrae and the transverse processes; it covers the Rotatores Spinae and is directly beneath the Semi-spinalis in the dorsal and cervical regions. These three muscles, the Rotatores Spinae, the Multifidus Spinae and the Semi-spinalis Dorsi and the Colli occupy the Spino-transverse groove the entire length of the spinal column.

The action of the multifidus spinae is to bend the spinal column backward and to assist the erector spinae in holding the spinal column erect. These muscles are especially concerned in the rotation of the spine and by their constant, co-ordinate action perform a very special function in resting the other muscles of the back. In the action of rotation the vertebrae will be rotated in the opposite direction to the muscle that is in action. These muscles receive their supply of mental impulses through nerves emitting along the entire spine from the third cervical to the base of the sacrum.

#### Rotatores Spinae. Fig. 116.

The Rotatores Spinae form a series of muscles from the second dorsal vertebra to the twelfth dorsal vertebra. Each muscle is composed of a small bundle of fibers which arise from the transverse processes of the vertebrae. They pass upward and are inserted into the laminae of the vertebra next

above. The action of these muscles is principally that of rotation. The vertebrae being rotated in the opposite direction from the muscle in action.

**Supra-Spinales. Fig. 115.**

Supra-spinales are small bundles of muscular fibers found attached to the tips of the spinous processes in the cervical region only.

**Inter-spinales. Fig. 114.**

The Inter-spinales muscles are short bundles of fibers found between the spinous processes. They are usually absent in the dorsal region, but are well developed in the lumbar region, but not quite so well developed in the cervical region. They extend from the inferior border of the spinous process of one vertebra to the superior border of the spinous process of the vertebra next below.

The principal action of these muscles is to assist in bending the cervical and lumbar regions toward the posterior. These small muscles receive their mental impulses through the nerves emitting from the spinal cord in the cervical and lumbar regions.

**Inter-Transversales. Fig. 114.**

The Inter-transversales are a series of muscles found between the transverse processes of the vertebrae. They are indistinct in the dorsal region. Their action is to assist in the lateral bending of the spine and they receive their mental impulses through the spinal nerves in the different regions.

**Extensor Coccygeus. Fig. 114.**

This is a small muscle that is attached to the last segment of the sacrum and the tip of the coccyx. The action is as the

name indicates, to extend the coccyx. It receives mental impulses through the sacral branches of the spinal nerves.

**Rectus Capitis Posticus Major. Fig. 114.**

The rectus capitis posticus major is a short, strong muscle which arises from the spinous process of the axis. Passing upward it is inserted into the occipital bone just beneath the inferior curved line. The action of this muscle is to rotate the head and draw it backward.

**Rectus Capitis Posticus Minor. Fig. 114.**

This is a short muscle which arises from the lateral mass of the atlas and is inserted into the occipital bone just beneath the inferior curved line. It lies just medially to the rectus capitis posticus major and its action is just the same.

**Obliquus Capitis Superior. Fig. 114.**

The obliquus capitis superior arises from the transverse process of the atlas and passing upward is inserted into the occipital bone between the superior and inferior curved lines. The action of this muscle is the same as the last two mentioned.

**Obliquus Capitis Inferior. Fig. 114.**

The obliquus capitis inferior is a short muscle arising from the spinous process of the axis and is inserted into the transverse process of the atlas. The action of this muscle is upon the atlas rather than upon the head. It rotates the atlas and in so doing assists in rotating the head.

These last four named muscles—the rectus capitis; posticus, major and minor; the obliquus capitis, superior and inferior, all receive their supply of mental impulses through the divisions of the first pair of spinal nerves.

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